392

THE Chemical Age

VOL. LXXII 25 JUNE 1955 No. 1876

Consult GALLENKAMP...

For your
LABORATORY REQUIREMENTS
including
PETROLEUM TESTING APPARATUS
TO IP and BS SPECIFICATIONS

Catalogue No 544 sent on request.

Gallenkamp

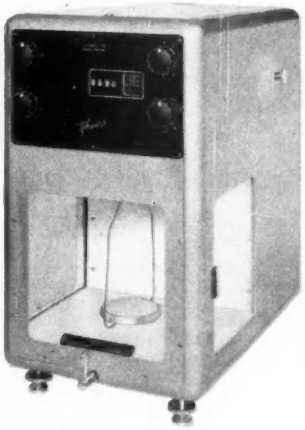
Photographs by kind permission of Esso Petroleum Co. Ltd.

A. GALLENKAMP & CO., LTD., 17-29 SUN STREET, LONDON, E.C.2

Rec'd JUL 12 19 B. P. L

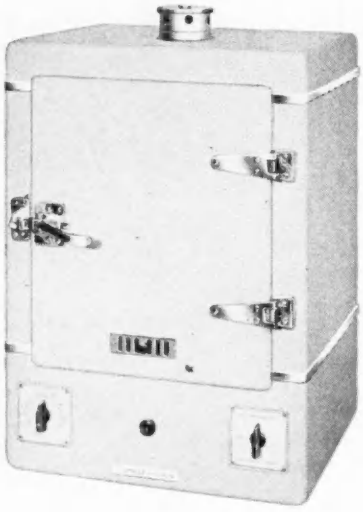
BOSTON PUBLIC LIBRARY
REFERENCE DEPARTMENT

Towers for all Laboratory Apparatus



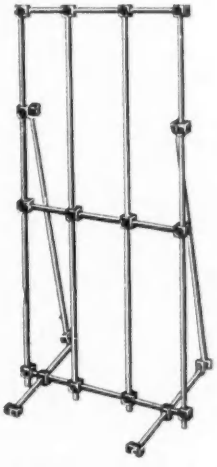
MODEL 205

Constant load, automatic direct reading balance. Capacity, 200 grms. Reading to 0.1 mg. No loose weights required.



TOWERS UNIVERSAL OVENS

Available in three temperature ranges, 0–110° C., 0–200° C. and 0–300° C. Accurate thermostatic control with dial calibrated in degrees centigrade. Attractive and durable cream enamel finish.



LABLOX SUPPORT FRAMES

Light, convenient and corrosion resistant. From standard sets of components a large variety of frames can be built easily and quickly.

Full details of all the above and catalogues of Balances, Graduated Glassware, Hydrometers and other Laboratory equipment will be sent on request.

On display at our stand No. 15F, The British Instrument Industries Exhibition, 28th June to 9th July.

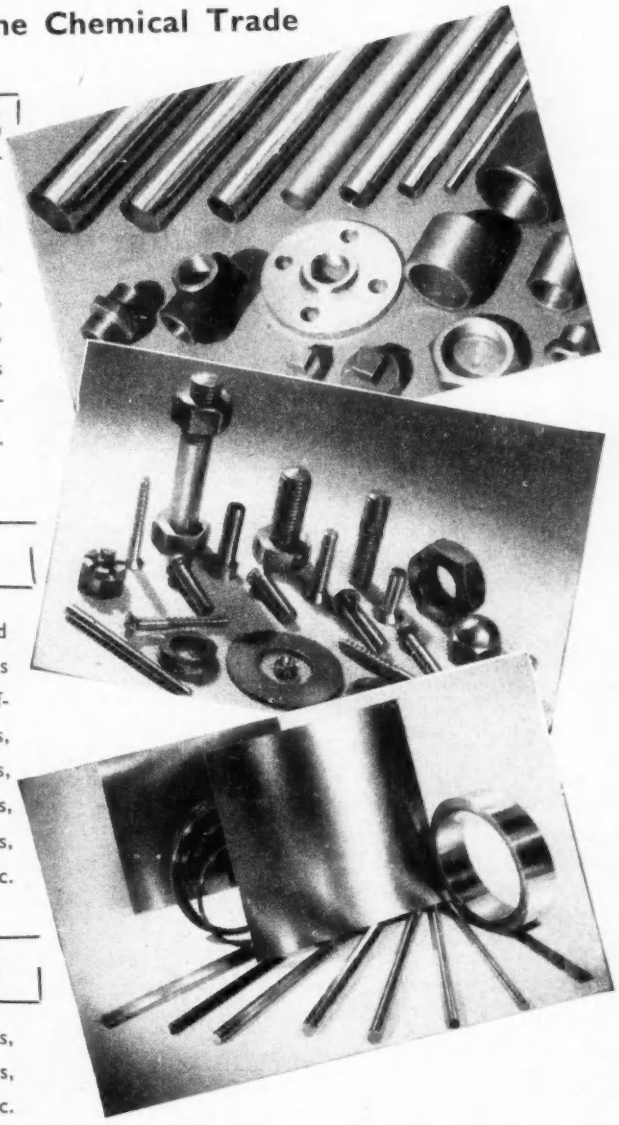
J.W. TOWERS & CO. LTD.

HEAD OFFICE AND WORKS WIDNES TELEPHONE WIDNES 2201-5

Manchester	Liverpool	Stockton-on-Tees	London
44, Chapel Street Salford 3 (Blackfriars 2677)	134, Brownlow Hill Liverpool 3 (Royal 4074)	28, Bridge Road (Stockton 65141)	Wallingford Road Industrial Estate Uxbridge, Middx. (Uxbridge 8461)

STAINLESS STEEL

An Essential to the Chemical Trade



TUBES & FITTINGS

Solid-Drawn or Welded and Polished Tubes in all sizes, Tees, Bends, Couplings, Elbows, Crosses, Plugs, Back-nuts, Valves, etc. Flanges supplied unmachined or screwed to B.S.P. Threads.

SCREWS

Woodscrews, Metal Thread Screws, Hexagon Bolts and Setscrews. Self-Tapping Screws, Nuts, Washers, Rivets, Studs, Taper and Cotter Pins, Dome Nuts, Castle Nuts, Wing Nuts, Nails, Etc.

MATERIALS

Sheets, Strip, Rods, Bars, Angles, Formed Sections, Wire, Gauze, Chain, Etc.

LONDON METAL WAREHOUSES LTD

SERVICE TO THE CHEMICAL TRADE

SUMMER ROAD, THAMES DITTON, SURREY

Phone : Emberbrook 4485 and 5661 (11 lines)

London Showrooms : 15-17, Edgware Road, W.2.
Phone : Paddington 8780 and 2519

Manchester : 306, Deansgate.
Phone : Blackfriars 9022 & 9610

Stockport : Brinksway Bank Mill.
Phone : Stockport 3686-7, 5420, 5429

Birmingham : Gazette Buildings, 168, Corporation Street. *Phone* : Central 4751/5.

Newcastle-on-Tyne : 25, Collingwood Street. *Phone* : Newcastle-on-Tyne 24244.

FACTS ON DRYING TIMES

A high rate of drying depends on preventing the air over the sample from becoming saturated and in normal ovens without fan, convection alone gives such low turbulence that saturation may take place.

In tests on trays of flour samples in a convection oven, it was shown that the resultant high humidity on the surface of the trays caused irreversible changes in the samples and the results with a full oven always differed from those in a nearly empty oven.

With a properly designed fan oven, using a forced warmed fresh air intake, this trouble was eliminated and the air throughput was measured as

2½ changes of fresh air per minute

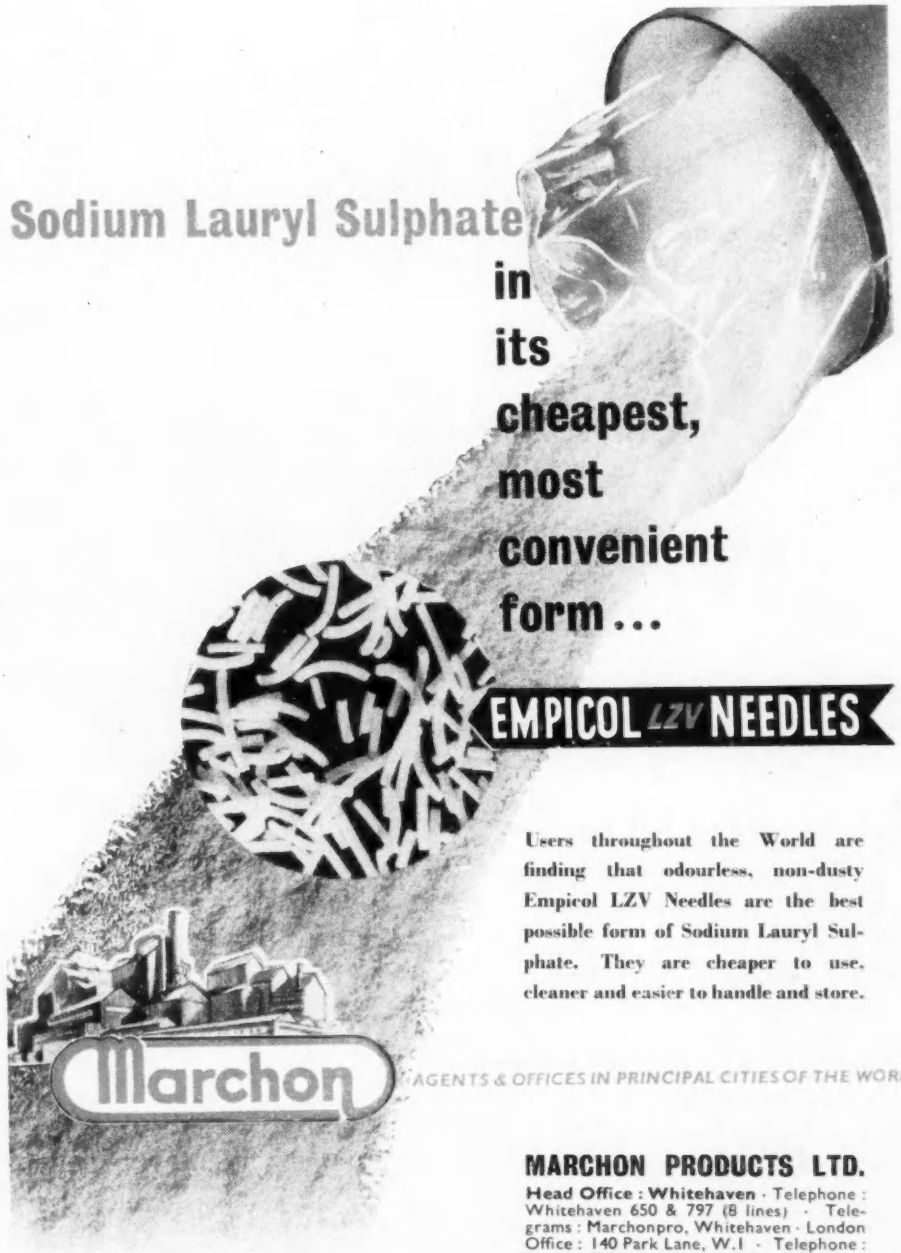
In further tests on yeast samples, drying time was reduced from 4 hours to 50 minutes by using the forced air intake

This is why we say that—

THE EVEN OVEN WITH WARMED FRESH AIR INLET
MAKES ALL ORDINARY DRYING OVENS OBSOLETE

TOWNSON & MERCER LTD.

CROYDON Telephone : THOrnton Heath 6262 ENGLAND



Sodium Lauryl Sulphate in its cheapest, most convenient form...

EMPICOL LZV NEEDLES

Users throughout the World are finding that odourless, non-dusty Empicol LZV Needles are the best possible form of Sodium Lauryl Sulphate. They are cheaper to use, cleaner and easier to handle and store.

Marchon

AGENTS & OFFICES IN PRINCIPAL CITIES OF THE WORLD

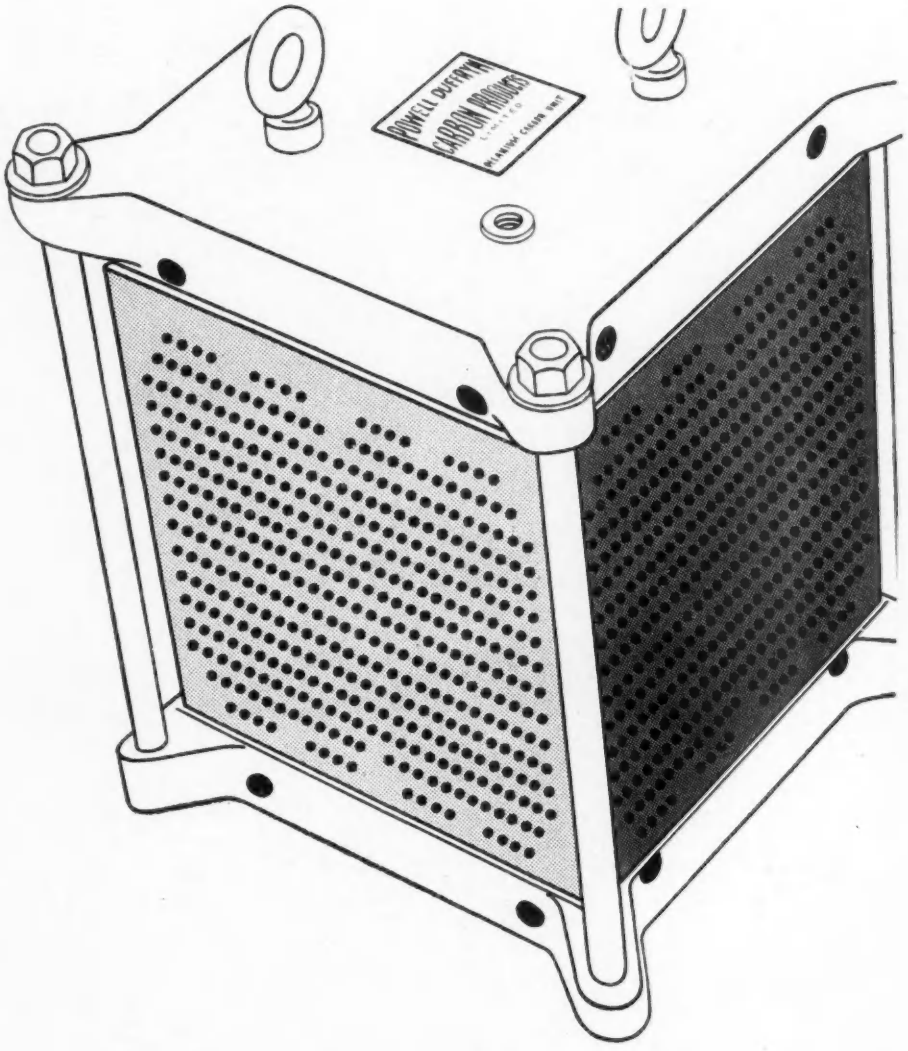
MARCHON PRODUCTS LTD.

Head Office : Whitehaven · Telephone : Whitehaven 650 & 797 (8 lines) · Telegrams : Marchonpro, Whitehaven · London Office : 140 Park Lane, W.1 · Telephone : Mayfair 7385 (3 lines) · Telegrams : Marchonpro, Audley, London.

Manufacturers of : **ORGANIC DIVISION :** fatty alcohol sulphates **(EMPICOLS)**, emulsifiers **(EMPILANS)**, self-emulsifying waxes **(EMPIWAXES)**, alkyl aryl sulphonates **(NANSAS)** and other detergent bases, additives and emulsifiers in powder, paste and liquid forms ; higher primary fatty alcohols **(LAUREX)**. **INORGANIC DIVISION :** phosphoric acid and complex phosphates **(MARPHOS and EMPIPHOS)**.

MAR 1929

51



THE MODERN GRAPHITE HEAT EXCHANGER

a specialised design providing unsurpassed heat transfer, corrosion resistance, compactness and robustness

DELANIUM
CARBON & GRAPHITE

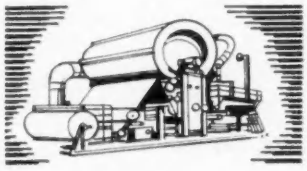
POWELL DUFFRYN CARBON PRODUCTS LIMITED

Springfield Road, Hayes, Middlesex. Telephone: Hayes 3994-8

THE ALUMINA Co. LTD.

MANUFACTURERS OF ALUMINIUM SULPHATE

FOR

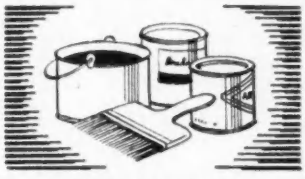


PAPER MAKING

FOR

WATER PURIFICATION

FOR



COLOUR MAKING

FOR

EFFLUENT TREATMENT

FOR

PHARMACEUTICALS

FOR

HORTICULTURE

The above are but a few of the main uses of ALUMINIUM SULPHATE. We should be pleased to supply further details on request

IRON BRIDGE WORKS · WIDNES

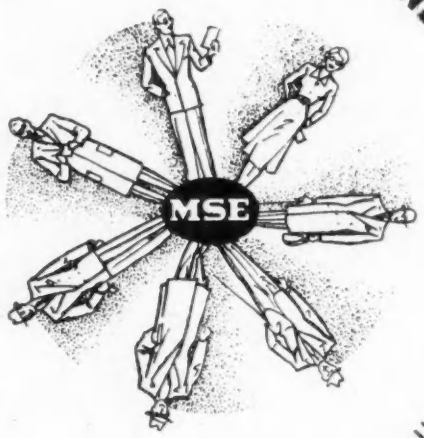
LANCASHIRE. Telephone: Widnes 2275

Interest in

Centrifuges

with new ideas

revolves round STAND 16 BLOCK C NON EXHIBITION



BRITISH INSTRUMENT INDUSTRIES

A complete new range of centrifuges incorporating some novel ideas will be on show on the MSE Stand at Earls Court (June 28 to July 9) together with the latest MSE Homogenizers and Microtomes.

MEASURING & SCIENTIFIC EQUIPMENT LTD.
SPENSER STREET, LONDON, S.W.1 VICtoria 5426

METALOCK

" Metalock " is the Trade Mark of the Metalock Repair Service, Inc., Long Island City, New York, for the special alloy strips used in machinery repairs.

COLD REPAIR OF CASTINGS

Used and approved by leading firms throughout the world

SUCCESSFUL REPAIRS FOR

Imperial Chemical Industries Ltd.
Iraq Petroleum Co. Ltd.
Midland Tar Distillers Ltd.
National Benzole Co. Ltd.
The South Bank Chemical Co. Ltd.
Esso Transportation Co. Ltd.

NO DISMANTLING · NO REASSEMBLING

GUARANTEED REPAIRS
CARRIED OUT ON SITE

BRITISH DEPOTS

BRISTOL	*Bristol* 26741	GLASGOW	*City* 7203
CARDIFF	*Cardiff* 29719	NEWCASTLE	*Newcastle* 24808
COVENTRY	*Coventry* 2469	GRIMSBY	*Grimsby* 56499
		LIVERPOOL	*Central* 3820

METALOCK organisations in the following countries :—

Australia, Austria, Benelux, Cyprus, Syria and the Lebanon, Denmark, East Africa, Eire, France, Germany, India, Italy, Malaya Peninsula, Morocco, New Zealand, Norway, Pakistan, Portugal and Spain, South Africa, Sweden, U.S.A.

METALOCK (BRITAIN) LIMITED

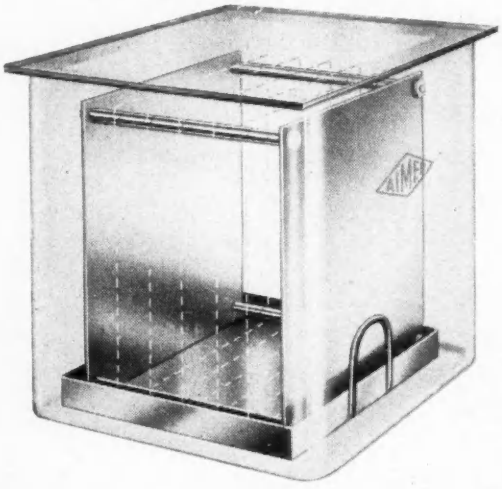
GRAND BUILDINGS · TRAFALGAR SQUARE · LONDON, W.C.2.

Telephone : WHitehall 4803, 5901/2 Cables : Metlokcast, Rand, London

A UNIVERSAL OUTFIT FOR PAPER CHROMATOGRAPHY

for one- and two-way separations by ascending or descending solvent flow, or for circular chromatography.

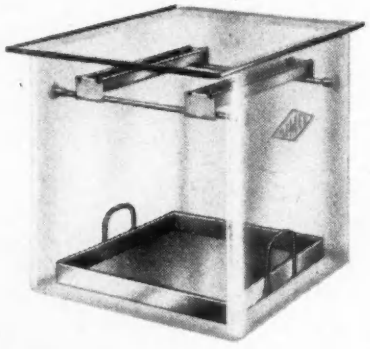
See CHEM. & IND., February 27th, 1954. Page 243.



The apparatus is based on an all-glass tank, 12″ cube, with a Chromatographic Frame, modified in size from that used by Datta, Dent & Harris (*Science*, 1950, *112*, 621) to allow overnight runs on paper 10″ square. The frame will accommodate 5 two-way chromatograms, or up to 50 one-way chromatograms, with ascending solvent flow in each case.

The frame method with ascending solvent is recommended for all routine or exploratory work. Its advantages are—the ease of handling, spotting, and drying the papers, especially for two-way separations ; the very small amounts of material required ; the excellent separations achieved with short, overnight runs ; the very large number of separations which can be conducted simultaneously under identical conditions ; and an unbreakable apparatus, economical in bench space, solvents and paper.

For the separation of materials with low Rf values, requiring a longer solvent run than is the case with the Frame, the apparatus is readily converted to a conventional descending-flow apparatus. It will then accommodate up to 8 of the same 10″ square papers, serrated at the lower edge to allow solvent to drip off into a tray. The tank will hold 6 of the trays in which 8″ diam. circular chromatograms can be run.



Other chromatography equipment, including All Glass Outfits, Fraction Collectors, and Desalting Apparatus, supplied. Prices and details on application.

AIMER PRODUCTS LIMITED

56-58 ROCHESTER PLACE, GULLIVER 3618, 6466.
CAMDEN TOWN, LONDON, N.W.1, ENG.

Individually Planned

and designed for your requirements

Our modern laboratories are individually planned and designed for their particular purposes in Research, Industry, Education and Medicine: they can also be planned with a view to future rearrangements. Sixty years widespread experience enables us to offer suggestions and designs based on the best of present-day developments.

Laboratories recently equipped by us :—Research and Routine . . . . Mars Ltd., Slough
Botany and Physics . . . University College, London.
Pathological . . . . Gordon Hospital, London.
Routine . . . . . May and Baker, Dagenham.
Research and Routine . . . International Chemical Co. Ltd., London.
Chemistry and Physics . . . University College, Hull.

Consult our Technical Department without obligation.

CHARLES HEARSON & Co. Ltd.
Laboratory furnishers & apparatus manufacturers
68 WILLOW WALK, BERMONDSEY, LONDON, S.E.1.
BERmondsey 4494 (4 lines)

ULTRASORB ACTIVATED CARBON

AND

SOLVENT RECOVERY PLANT

We have long experience in designing solvent recovery plants and in manufacturing activated carbon of various grades suitable for different purposes. Plants supplied twenty-five years ago still maintain high efficiency with reliability and safety. ULTRASORB carbons are available for recovery of most industrial solvents, benzole extraction, water purification and other gas and liquid phase applications.

BRITISH CARBO NORIT UNION LIMITED

176, BLACKFRIARS ROAD, LONDON, S.E.1.

TELEPHONE: WATERLOO 7744 CABLE: BRICARBUN SEDIST, LONDON

WIREWORK

and

WOVEN WIRE

Sieving	Window Guards
Screening	Machinery Guards
Strainers	Baskets
Wire Brushes, etc.	Trays, etc.

Chain Link Fencing

F. W. POTTER & SOAR LTD.

PHIPP STREET - - LONDON, E.C.2

Telephone—Bishopsgate 2177

CONSULT

T. DRYDEN LTD.

THE SOUTH WALES LABORATORY FURNISHERS

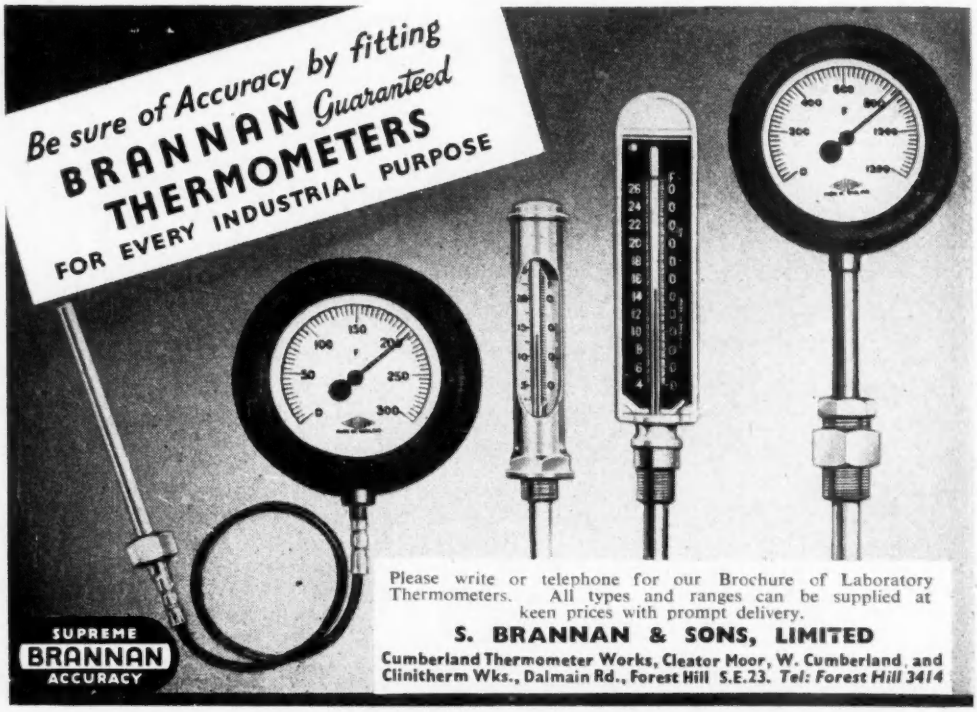
LANDORE-SWANSEA

WHEN YOU FURNISH OR EQUIP
YOUR LABORATORY

LABORATORY FURNITURE
A SPECIALITY

WHOLESALE DISTRIBUTORS PHOTOGRAPHIC
AND VISUAL AID EQUIPMENT

Telephone . . . . . SWANSEA 55844/5



Please write or telephone for our Brochure of Laboratory Thermometers. All types and ranges can be supplied at keen prices with prompt delivery.

S. BRANNAN & SONS, LIMITED

Cumberland Thermometer Works, Cleator Moor, W. Cumberland, and Clinitherm Wks., Dalmain Rd., Forest Hill S.E.23. *Tel: Forest Hill 3414*

AN ESSENTIAL PART OF YOUR LABORATORY EQUIPMENT—

WHATMAN
FILTER PAPERS

The Whatman range covers all requirements of the chemist in every branch of industry and research including—

QUANTITATIVE and **QUALITATIVE WORK**
ORDINARY and **GRAVIMETRIC ANALYSIS**
CHROMATOGRAPHY, and
ELECTROPHORESIS

Supplies may be obtained through all regular Whatman suppliers

Sole Sales Agents:
H. REEVE ANGEL & CO. LTD.,
9 Bridewell Place, London, E.C.4.

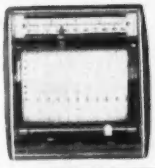
Manufacturers:
W. & R. BALSTON LTD.,
Maidstone, Kent.

FOXBORO
REG. U.K. TRADEMARK NO. 683659
Instruments

GRAPHIC & CONSOLE

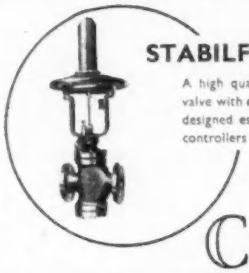
MODEL 53/58 CONSOTROL

A complete recorder and controller small enough for graphic or console presentation and occupying a panel space no larger than 6" x 6".



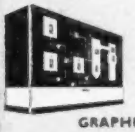
MODEL 52 CONSOTROL

Another high-grade instrument in the same series but designed for indicating and controlling. The case dimensions are 7 1/16" high by 3 1/8" wide.



STABILFLO VALVES

A high quality air-operated control valve with exponential characteristic, designed especially for use with the controllers shown on this page.



GRAPHIC

CONSOLE

CONVENTIONAL

MODEL 40 RECTANGULAR

A well-known and well-proven instrument, measuring 17" high by 14 1/2" wide and available for indicating, recording and/or controlling with either mechanical or Dynalog electronic measuring systems

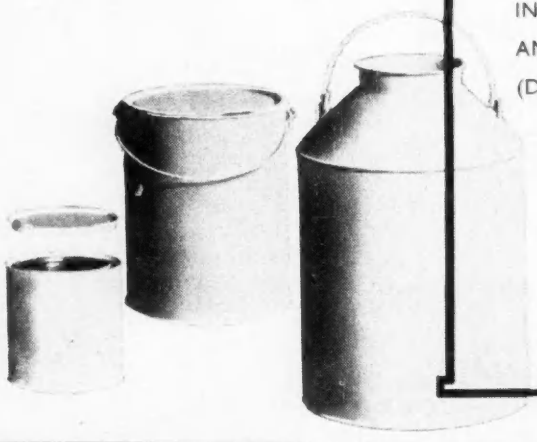
ROUND FORM SERIES

This series includes the simple concentric indicator, the recorder, as illustrated, together with the indicating or recording controller with On/Off or Proportional action.

FOXBORO-YOXALL LTD
LOMBARD RD., MERTON, LONDON, SW19
TELEPHONE NUMBER LIBerty 2461

CONVENTIONAL

THE HOUSE OF FARWIG



TIN-PLATE CONTAINERS

INCLUDING ROUND TAPERS IN A RANGE OF FITTINGS AND ALSO DEEP CHANNEL (Doubletite) LEVER LID, Etc.

J. F. FARWIG Co Ltd

208-214 YORK ROAD
BATTERSEA
LONDON, S.W.11

Telephone : Battersea 7008
T.A. Calorigen, Batt, London.

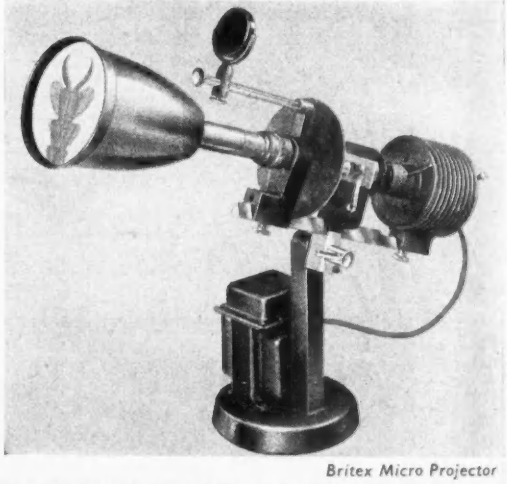
EST. 1809

BRITEX Optical laboratory equipment and apparatus

We specialise in the manufacture, distribution and development of precision quality optical instruments for industry, research, medicine and education. Details of complete range gladly sent on request.

MICROSCOPES
MICRO-PROJECTORS
MAGNIFIERS
CAMERA LUCIDAS
MICROTOMES
LINEN PROVERS

Catalogue gladly sent on request

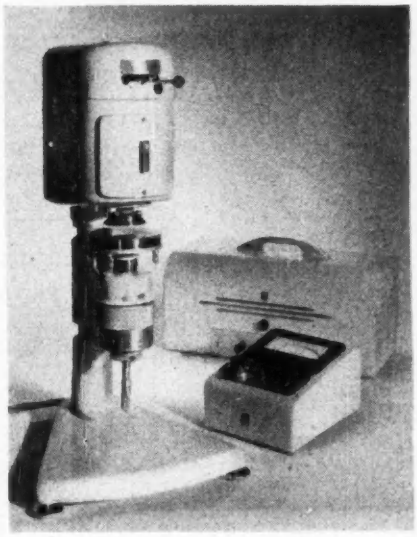


Britex Micro Projector

BRITEX (SCIENTIFIC INSTRUMENTS) LTD

523-4 BANK CHAMBERS, 329 HIGH HOLBORN, LONDON, W.C.1
Telephone : HOLborn 0902 & 7166

VISCOSITY MEASUREMENT



FERRANTI-SHIRLEY CONE & PLATE VISCOMETER

This instrument is a cone and plate viscometer of advanced design which enables the flow behaviour of many types of simple or complex fluids to be examined.

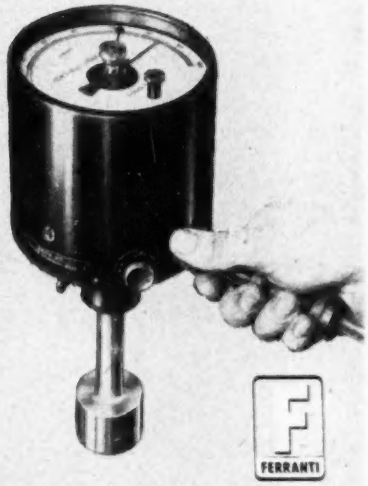
- Constant rate of shear, variable 20-20,000 sec^{-1} (approx.)
- Cone speeds variable from 10 to 1,000 r.p.m. or 1 to 100 r.p.m.
- Micrometer adjustment of gap settings

(Please write for List IN.126.)

FERRANTI PORTABLE VISCOMETER

A portable viscometer for industrial use which satisfies laboratory standards of accuracy. Gives rapid continuous readings of viscosity and flow properties of liquids or semi-liquids.

(Please write for List IN.125)

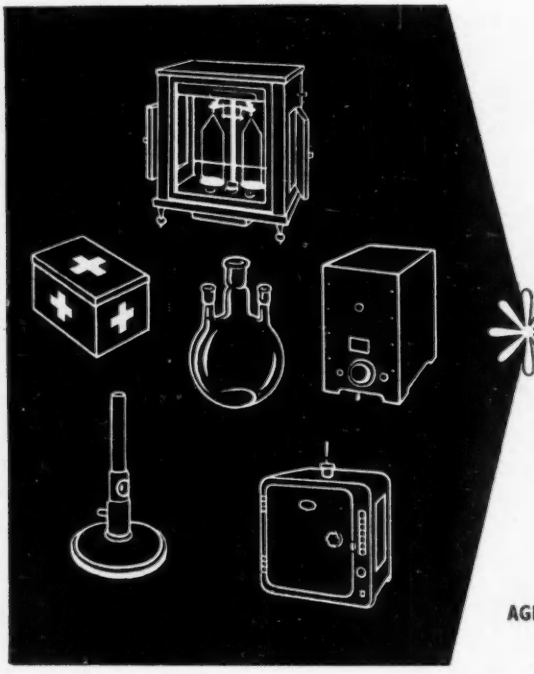


FERRANTI

FERRANTI LTD. MOSTON · MANCHESTER 10

LONDON OFFICE: KERN HOUSE, 36, KINGSWAY, W.C.2.

FI 151



* Balances
* Furnaces
* Ovens
* Glassware
* Filter Papers, etc.

Middleton & Co Ltd
LABORATORY FURNISHERS &
MANUFACTURING CHEMISTS
MIDDLESBROUGH
(TELEPHONE: 44361)

* E-MiL Scientific Apparatus etc.
  Hopkin & Williams Chems.
* First Aid & Ambulance
  Requisites

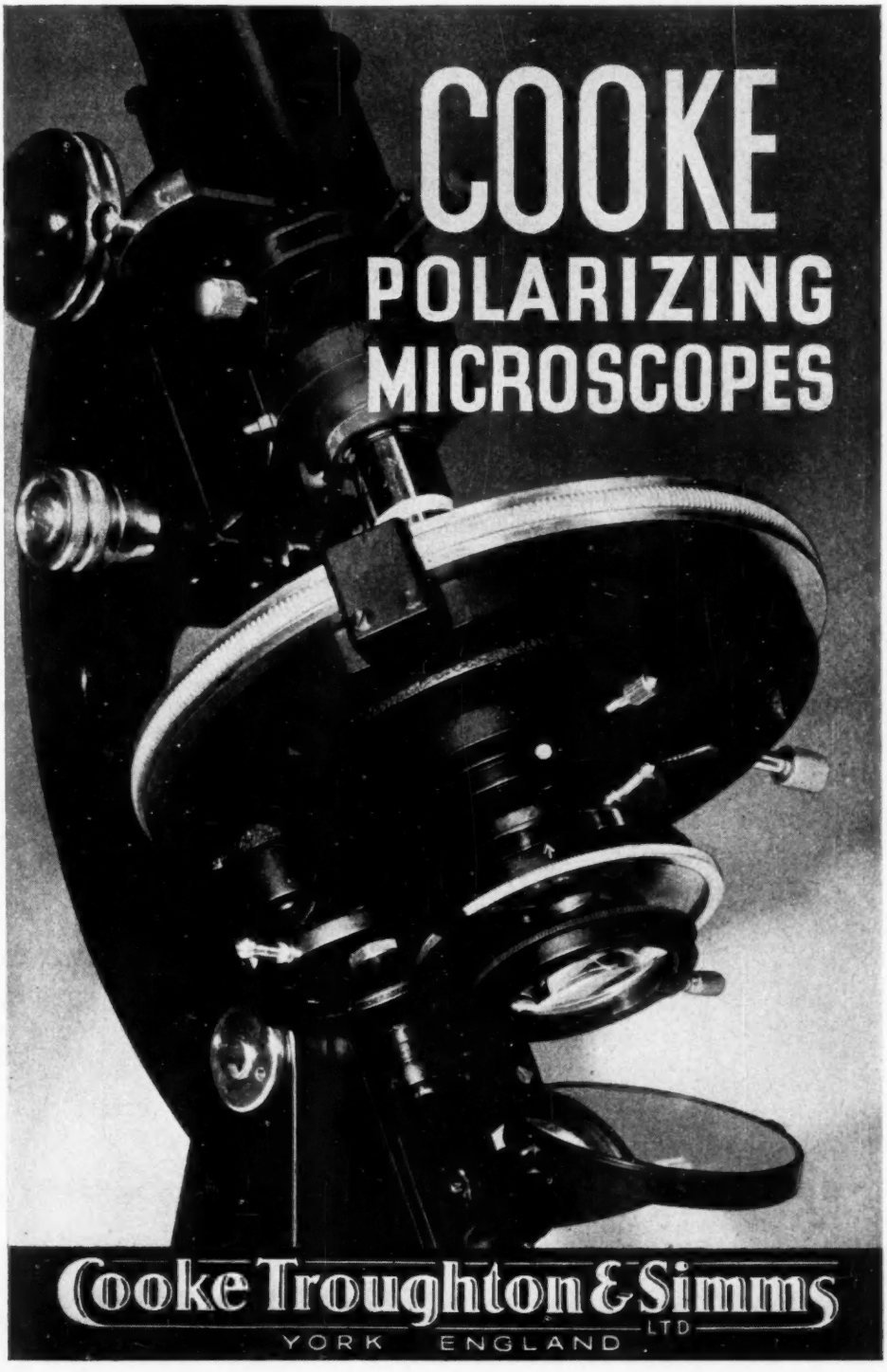
AGENTS AND STOCKISTS FOR BAIRD & TATLOCK
CATALOGUE ON REQUEST

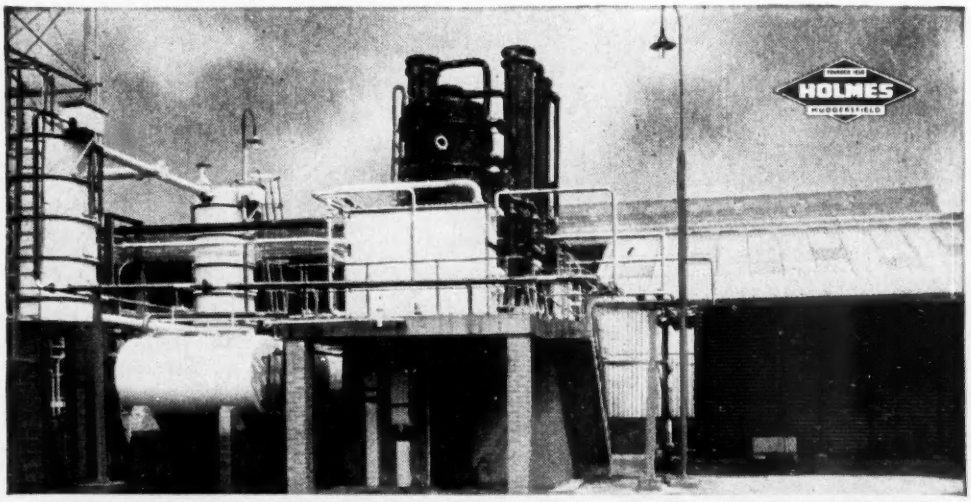
Fluor Spar

- FLUORSPAR ACID GRADE
- METALLURGICAL GRADES
- LEAD & ZINC CONCENTRATES

Glebe Mines Ltd.

EYAM, Nr. SHEFFIELD
TELEPHONE: EYAM 281-282
TELEGRAMS: "FLUORIDES"


COOKE
POLARIZING
MICROSCOPES
Cooke Troughton & Simms LTD
YORK ENGLAND



SOLVENT RECOVERY BY OIL WASHING

The photograph shows carbon bi-sulphide recovery plant installed in one of Messrs. Courtaulds factories

W. C. HOLMES & CO. LTD
HUDDERSFIELD · LONDON · BIRMINGHAM

4276-4

electric furnaces

for research and production

tube
muffle
crucible
continuous
trolley
spherical
rotary

500°C — 1750°C

Many standard sizes. *Special sizes and designs a feature of our work.*

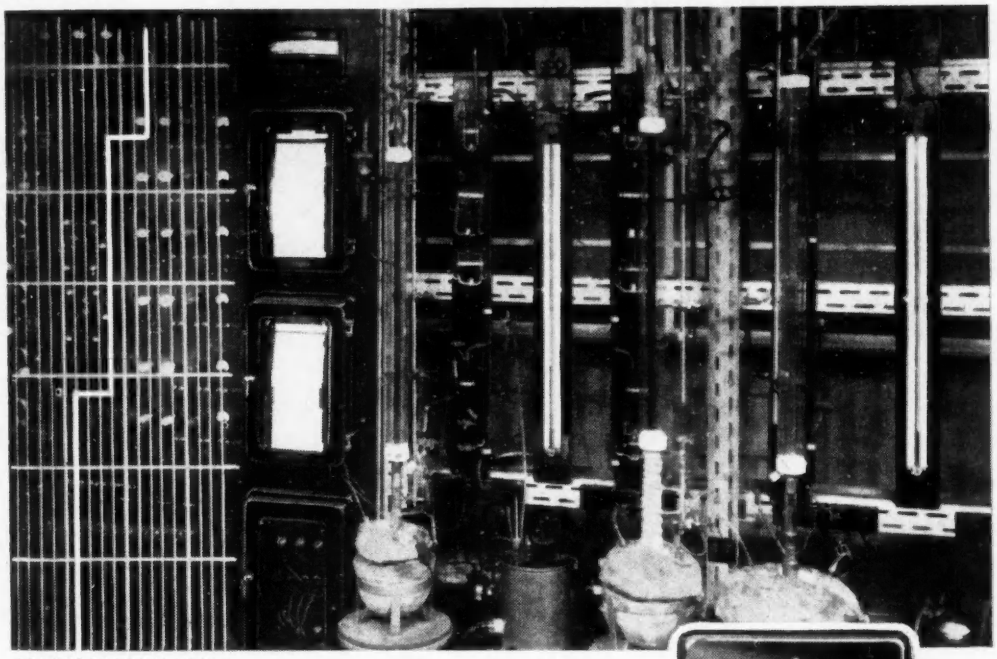
R. M. CATTERSON SMITH LTD.

Exhibition Grounds

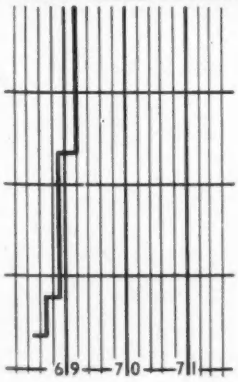
Telephone——WEMBLEY——4291

Makers of Electric Furnaces for over 30 years

TEMPERATURE measurement



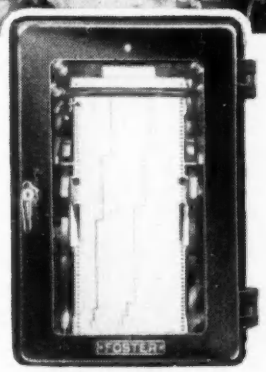
Photograph by courtesy of the C.T.R.A.



FRACTIONISATION.

For the precise measurement of fractionating column still-head temperatures this Foster 8-point cascade range temperature recording equipment was installed by the Coal Tar Research Association. In their Laboratory resistance thermometer element temperatures are recorded on open scale charts, the required range interval being selected by switching. Discrimination of reading is to within ·2° C. over the range 0–300° C.

This is only one application where Foster instruments are being used when close readings and high accuracy of measurement are essential. May we quote for your particular requirements?



Foster 7" Strip Chart Recorder giving single or multi-point records on charts (maximum 6 points per instrument), range 0–15° C., 0–25° C. and 0–100° C., with cascade range calibration to cover temperature zones of up to 300° C.

RESILIA FOSTER INSTRUMENTS

FOSTER INSTRUMENT CO LTD LETCHWORTH HERTS ENGLAND

Telephone: Letchworth 984-5-6 Telegrams: Resilia, Letchworth

FSM

auto-matic burner ignition

FOR GAS OR OIL

Practically all lighting-up procedures can now be carried out automatically and safely by one of the Elcontrol FSM units.

Based on the monitoring of the pilot and/or main flame by an Infra-Red sensitive cell, the FSM automatic Controllers give push-button starting, timed pre-ignition purging, timed ignition, lock out on failure to light-up and running flame failure protection.

Our Advisory Service is at your disposal.

TRADE E MARK

ELCONTROL LTD

10 WYNDHAM PLACE, LONDON, W.1.

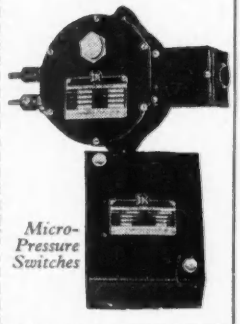
AMBassador 2671

PRESSURE SENSITIVE K·D·G

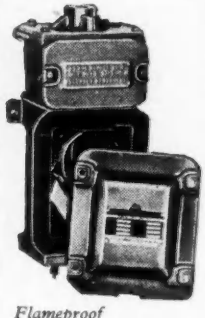
PRESSURE SWITCHES

with corrosion protection

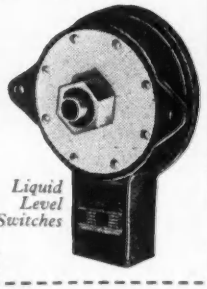
Illustrated is part of our range of pressure switches with ranges of 1" w.g. to 8,000 lb. per sq. inch. For both gases and liquids with corrosion protection if necessary, and available with Flame proof enclosures. Certain types are available for Differential Pressure and Flow monitoring. Slow moving contacts for precise action or snap action for high current ratings. Relay and Auxiliary equipment, where necessary, can be supplied.



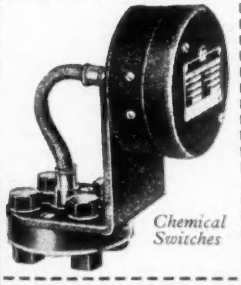
Micro-Pressure Switches



Flameproof Pressure Switches



Liquid Level Switches



Chemical Switches

Diaphragm Pressure Switches

BOURDON PRESSURE SWITCHES and DIFFERENTIAL PRESSURE SWITCHES also available.

Write for full details to :—

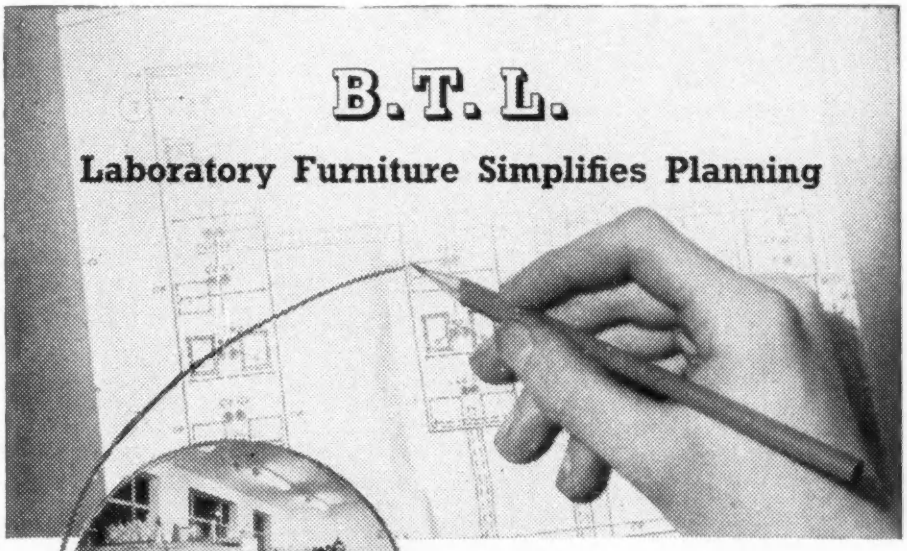
KDG INSTRUMENTS LTD

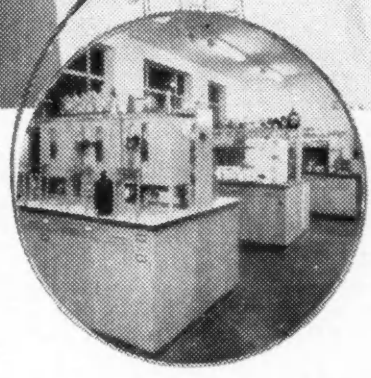
Purley Way, Croydon, Surrey.

Tel: THOrnton Heath 3868

B.T.L.

Laboratory Furniture Simplifies Planning





Over the past 50 years Baird & Tatlock (London) Ltd., have earned a world-wide reputation for designing and equipping laboratories for every aspect of science. Our experience is at the disposal of the scientific staff, the architects and civil engineers responsible for the planning of laboratories, from the earliest stages to the final minute details. Baird & Tatlock manufacture both Metal and Timber Laboratory Furniture. The selection by the customer of either of these ranges will obviously depend on the particular requirements and type of laboratory. B.T.L. Metal Unit Laboratory Furniture, has found increasing uses in certain types of laboratories, particularly those dealing with medical, food and agricultural sciences.

The following Industrial Laboratories in the United Kingdom have recently been fitted with B.T.L. Metal Unit Laboratory Furniture.

Alloa Glass Works, Scotland · **Associated Ethyl Co. Ltd.**, Bucks & Cheshire · **Bristol Aeroplane Co. Ltd.**, Bristol · **British Sugar Corporation Ltd.**, Nottinghamshire · **Frazer & Houghton**, Northern Ireland · **H. J. Heinz & Co. Ltd.**, Middlesex · **Ind Coope & Allsopp Ltd.**, Burton-on-Trent · **Imperial Chemical Industries Ltd. (Alfloc Division) Unilever Ltd.**, Sharnbrook, Beds. · **Menley & James**, London · **Parke Davis & Co., Ltd.**, Hounslow · **Pest Control Ltd.**, Chesterford Park · **Ransome & Marles Bearing Co. Ltd.**, Annfield Park · **St. Lukes Printing Works**, London · **Shell Refining & Marketing Co. Ltd.**, Cheshire · **Vine Products Ltd.**, Surrey **Weetabix Ltd.**, Northamptonshire · **Whiffen & Sons Ltd.**, London · **Yardley & Co. Ltd.**, London · **University of Nottingham, School of Agriculture**, Sutton Bonington · **Charing Cross Hospital**, London · **Imperial College of Science and Technology, Chemical Engineering**, London · **Queen's University**, Belfast · **Clinical Buildings, G.P.O. Research Station**, London · **Van Den Bergs & Jurgens, Margarine Works**, Purfleet.

The following Laboratories in the United Kingdom have recently been fitted with B.T.L. Wooden Laboratory Furniture.

The British Rayon Research Assn., London & Manchester · **The Nature Conservancy**, Dorset · **Ministry of Food**, Aberdeen · **King's College Hospital Research Unit**, London **Mile End Hospital**, London · **Llandough Hospital**, Cardiff · **Chelsea Hospital for Women**, London · **London University, School of Pharmacy**, London · **Hull University, Chemistry Dept.**, Hull · **Glasgow University, Inorganic Chemistry Dept.**, Glasgow · **King Edward School**, Surrey **Ilford Ltd.**, Essex · **Britannia Lead Co. Ltd.**, Kent · **Parke Davis & Co. Ltd.**, Hounslow · **Gloucester Aircraft Co. Ltd.**, Gloucester · **The Bushing Co. Ltd.**, Hebburn-on-Tyne · **Baker Platinum Ltd.**, London **Standard Yeast Co. Ltd.**, Essex · **Bristol Aeroplane Co. Ltd.**, Bristol · **Igranic Electrical Co. Ltd.**, Bedford · **Ransome & Marles Bearing Co. Ltd.**, Newark-on-Trent · **Reckitt & Coleman Ltd.**, Norwich **Westinghouse Brake and Signal School**, Chippenham · **Central Foundation School for Boys** · **York City Technical College.**

BT L

Member of SCIEX

BAIRD & TATLOCK

(LONDON) LTD.

Laboratory Fittings Division

FRESHWATER ROAD, CHADWELL HEATH, ESSEX

B.I.I. Exhibition. See the latest Exhibits on our Stand No. 10 Block F.

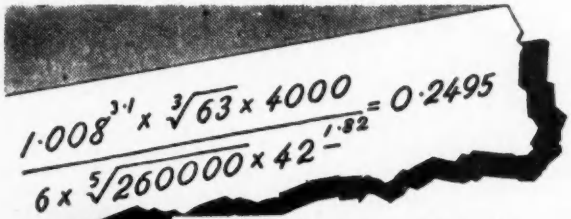
STAINLESS STEEL BOLTS · NUTS · STUDS

Acid and Heat Resisting Stainless Steel with Machine Cut Threads

All products are machined from Stainless Steel Bar Materials

THE SANDIACRE SCREW CO. LTD
SANDIACRE, NEAR NOTTINGHAM

TEL: SANDIACRE 2065/6
GRAMS: SCREWS, SANDIACRE



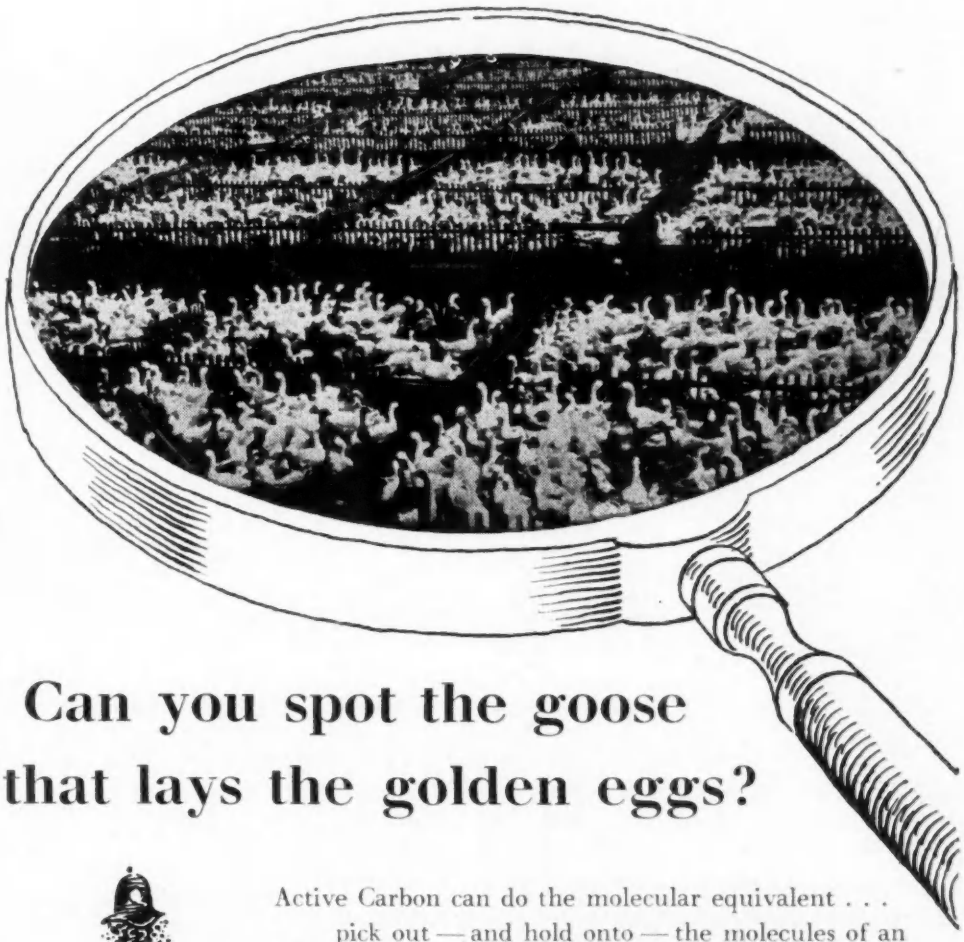
Pocket Size but as accurate as a 5ft 6" slide rule

The Otis King Calculator, with its 66" scales is more useful than any ordinary slide-rule. Problems like the above—and of course others less complicated—are solved in a few seconds: accurate results to *four or five significant* figures can be read.

It costs **47/6d.**—measures 6" by 1¼"—and is strongly made in metal, with plastic-coated scales.

The Otis King Calculator is obtainable from leading instrument dealers and drawing office suppliers or direct from :—

Carbic Limited (Dept. CA) 54 Dundonald Road, London, S.W.19
(LEAFLET ON REQUEST)



Can you spot the goose that lays the golden eggs?

Active Carbon can do the molecular equivalent . . . pick out — and hold onto — the molecules of an expensive solvent dispersed in the air, for instance.

In hundreds of dry-cleaning works, chemical works and paint shops the use of Active Carbon pays handsome dividends. But solvent recovery is only one of its gifts: it can also remove unwanted colours, unpleasant odours and tastes. It is used as a catalyst carrier in the manufacture of P.V.C.: and the purity of many foodstuffs and many pharmaceuticals owes a lot to Active Carbon; the experts in charge are

SUTCLIFFE SPEAKMAN

SUTCLIFFE SPEAKMAN & COMPANY LTD · LEIGH, LANCASHIRE · Telephone: Leigh 94
London Office: 2 Caxton Street, Westminster, S.W.1. Telephone: Abbey 5085

AIL

ALGINATES FOR INDUSTRY

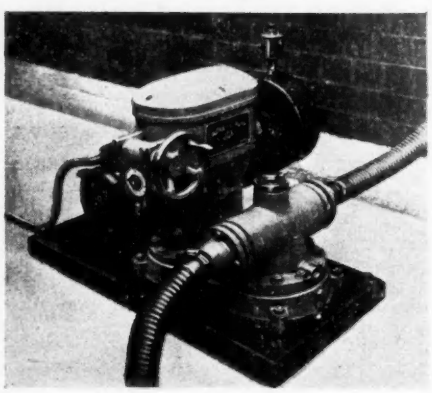
The salts and derivatives of alginic acid have a great variety of use over a wide industrial range. Those most generally used are sodium, ammonium, calcium and propylene glycol alginate, and 'Alginade', an ice cream stabiliser.

Alginate Industries are the proprietors of the Trade Marks:
MANUCOL (Reg.) **COLLATEX** (Reg.) **MANUTEX** (Reg.)
MANUCOL ESTER, WELGUM, MANUCET, ALGINADE.

Samples and technical data on request.

ALGINATE INDUSTRIES
LIMITED
WALTER HOUSE, BEDFORD STREET, STRAND, LONDON, W.C.2
Telephone: Temple Bar 0451

The SIMPULSIC PUMP

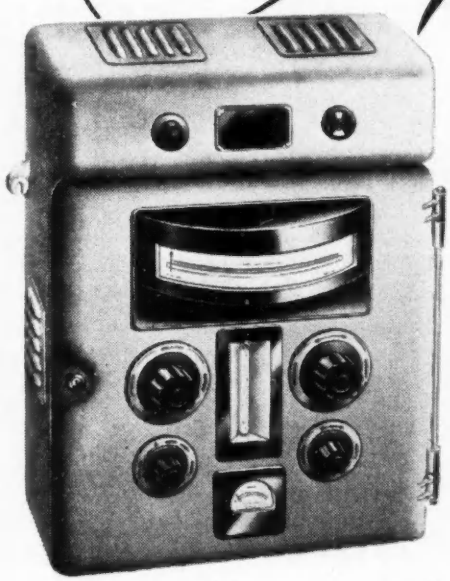


Here is an entirely new **variable capacity pump** specially designed for handling acids, alkalies, slurries, viscous fluids and other difficult liquids. It has **no glands** and **all passages and valves are of special chemical resisting rubber.** The output can be varied whilst the pump is running. Your enquiries are invited.

AMES CROSTA MILLS & CO., LTD.
HEYWOOD **LANCS.**
LONDON OFFICE: ABBEY HOUSE, VICTORIA STREET, S.W.1.

BAKER PLATINUM

HERSCH Oxygen Meter



FOR THE CONTINUOUS MEASUREMENT OF TRACES OF MOLECULAR OXYGEN IN GASES

An increasing number of metallurgical and chemical processes require an oxygen free atmosphere and the Hersch Oxygen Meter provides a means of ensuring that failure of purification plant or ingress of atmospheric oxygen through an unsuspected leak does not cause costly spoilage. The high sensitivity and rapid speed of response of the instrument enable it to be used both for laboratory investigation and production quality control in a wide range of applications.
The ranges covered are 0-10 and 0-100 volumes per million.

Write for leaflet giving full information. Technical representatives are always available for consultation and advice.

BAKER PLATINUM Division
Engelhard Industries Ltd.
52 HIGH HOLBORN, LONDON, W.C.I. CHAncery 8711

MAKERS OF ALL KINDS OF
APPARATUS FOR RESEARCH
AND WORKS LABORATORIES

THE SCIENTIFIC GLASS-BLOWING CO.
MANCHESTER
Telegrams: SOXLET M/c 13
SOLE - ADDRESS
Phone: ARDwick 1425

STANDARD
GROUND JOINTS

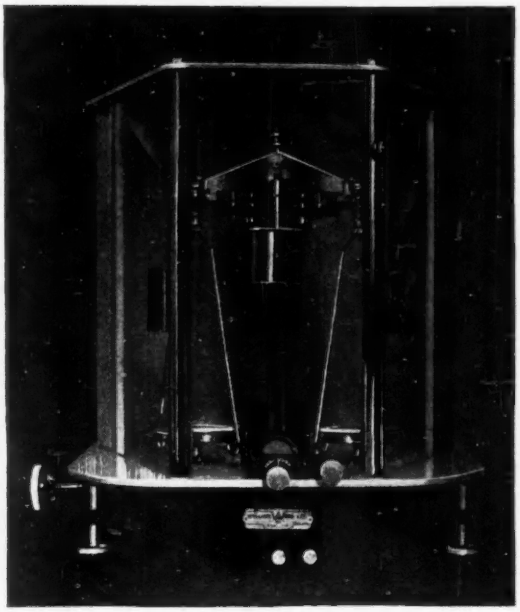
LIQUID AIR FLASKS AND
CYLINDERS, THERMOMETERS
BEAKERS, FLASKS AND GRADUATED WARE

270 OXFORD RD. • MANCHESTER 13

QUARTZ

TUBES, RODS AND SHEETS (transparent or translucent)
EQUIPMENT AND APPARATUS to customer's specification
CRUCIBLES, TRAYS AND IGNITION BOATS
(with highly polished inner surface)
FILTER CRUCIBLES
WATER BI-DISTILLATION STILLS
INFRA-RED DRIERS AND HEATERS
IMMERSION HEATERS
INFRA-RED SURFACE EVAPORATORS
HIGH AND LOW PRESSURE LAMP BURNER BODIES

FLEISCHMANN (LONDON) LIMITED
16 Northumberland Avenue,
LONDON, W.C.2
Telephone: Whitehall 0573 (5 lines)
Telegrams: Newmet London
Teleprinter No. 8016



THE

CRESTA

I

APERIODIC

BALANCE

FEATURING the new medium of liquid damping in a balance of durable and striking design co-ordinated with unrivalled speed and smoothness of operation.

Write for particulars

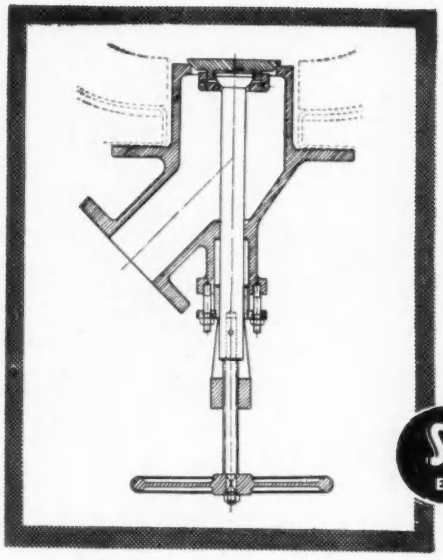
Manufactured throughout by

WILLIAM A. WEBB, LTD.

1—9, PERRYMANS FARM ROAD,
NEWBURY PARK, ILFORD, ESSEX.

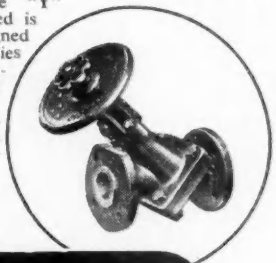
Telephone: Valentine 6370 *Telegrams: Accuracy Ilford.*

STOCKDALE FLUSH BOTTOM VALVES



and other types in Stelcalloy alloys

Diagram (left) indicates the flush bottom valve which will meet the need for removal of the notorious "dead pocket" in tiled vats and other vessels. Materials—Stelcalloy alloys (resistant to HCL, etc.), Nickel, Cast Iron, Monel Regulus. The "Y" valve illustrated is specially designed for arduous duties found in chemical works and oil refineries. Maintenance is reduced with minimum friction loss.



STOCKDALE
ENGINEERING LIMITED

Full information on request

CHEMICAL ENGINEERS, LONDON ROAD SOUTH, POYNTON, CHESHIRE
Telephone: Poynton 2601/2

dm SC 40

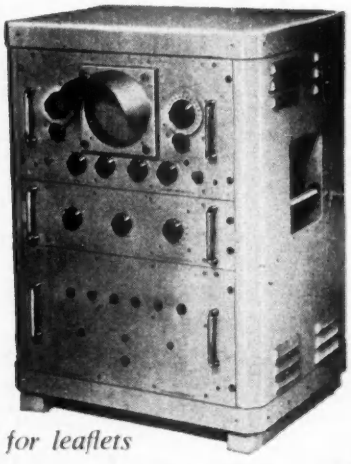
Cathode Ray POLAROGRAPH

for Accurate and Speedy Analysis

METALLURGICAL · INORGANIC · ORGANIC
BIOCHEMICAL · QUALITATIVE · QUANTITATIVE
ROUTINE · SPECIAL RESEARCH

Since its invention by Heyrovsky in 1925 the Polarograph has established itself as an essential tool in many Analytical Laboratories all over the world.

The Cathode Ray Polarograph greatly extends the scope of the polarographic technique. Its increased sensitivity, resolution and speed reduce the amount of chemical separation and concentration required and make possible many determinations which cannot be carried out in any other way.



Write for leaflets

SOUTHERN INSTRUMENTS LIMITED
SPECIAL PRODUCTS DIVISION
CAMBERLEY · SURREY **Telephone: Camberley 2230 (3 lines)**

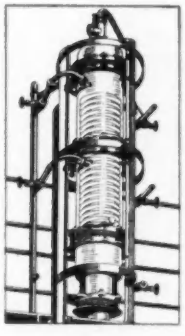
A skilful group of practical and technical experts

QUICKFIT Visible Flow

Q.V.F. Ltd builds

INDUSTRIAL PLANT IN GLASS

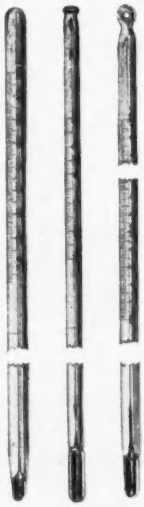
is ready to serve
you on any question of
the adaptation of
Industrial Plant in Glass
and Visible Flow pipeline
to your manufacture.
Constructive planning
or advice are yours to
command as well
as the largest
manufacturing facilities
in the country.
May we hear from you ?



Telephone : **STONE 511**

Q.V.F. LIMITED

Mill Street, Stone, Staffs.



ZECOL
REG. TRADE MARK

THERMOMETERS

REGD. TRADE MARK

CHEMICAL THERMOMETERS

REGD. TRADE MARK

HYDROMETERS

PHONE : LIBERTY 2283-6

G. H. ZEAL LTD.

GRAMS : ZEALDOM SOUPHONE LONDON

LOMBARD RD., MORDEN RD., MERTON, LONDON, S.W.19.

See our Stand No. 16 Block E at the B.I.I.E.

F. J. HONE & CO. LTD.

Specialists in the design and
Manufacture of Laboratory Apparatus

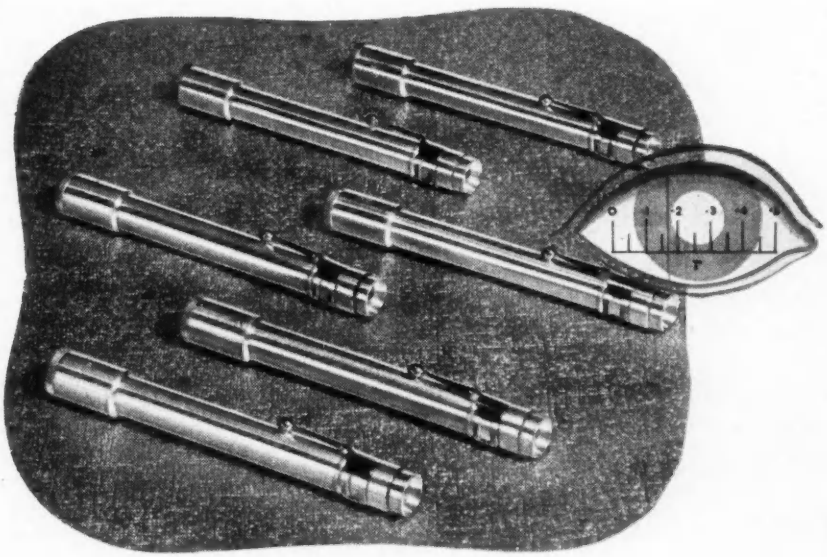
have pleasure in announcing their removal to larger premises at :

19, ELDON PARK,

LONDON, S.E.25.

Telephone - - - - - - - - - - - - ADDiscombe 3117

THE CK DOSIMETER



a radiation monitor for personal use

THE CK DOSIMETER is a personal monitor for indicating the integrated doses of Gamma and Hard X-ray radiation received by an individual. It is shaped like a fountain pen and conveniently carried in the pocket. The accumulated radiation exposure is determined by holding the Dosimeter to the eye and viewing the position of an internal fibre on a graticule calibrated from zero to 500 milli-roentgens in 25 mr steps. For further particulars of this instrument please write to:

CINEMA-TELEVISION LIMITED

A Company within the J. Arthur Rank Organisation

WORSLEY BRIDGE ROAD · LONDON · SE26

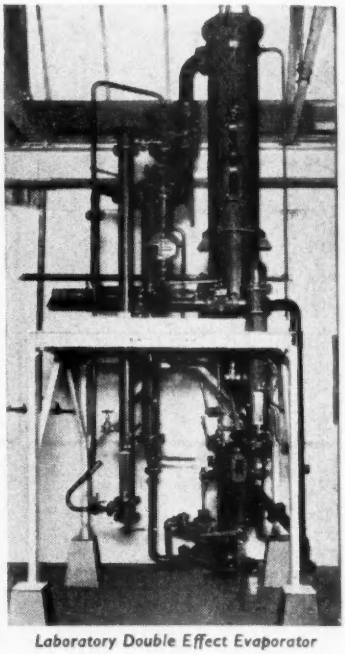
Telephone: HITher Green 4600

CHEMICAL PLANT & PROCESSES

The Kestner organisation serves many industries. In fact, wherever chemicals are manufactured or used it is more than likely that you will find some Kestner plant—it may be a stirrer or other small item—it may be a large spray drier or the entire process plant. Whatever it be, large or small, you will find it doing "a good job."

If you are needing new plant, Kestners can help you on any of the following subjects :—

ACID HANDLING • ACID RECOVERY PLANT • DRYING PLANT • EVAPORATION PLANT • FLUID HEAT TRANSMISSION SYSTEMS • GAS ABSORPTION & REACTION SYSTEMS • ISOLECTRIC SYSTEM FOR PROCESS HEATING • KEEBUSH • LABORATORY & PILOT PLANTS • STIRRERS & MIXING EQUIPMENT



Laboratory Double Effect Evaporator

Kestner's *The Chemical Engineers*

KESTNER EVAPORATOR & ENGINEERING CO., LTD. 5 GROSVENOR GARDENS, LONDON, S.W.1

VITREOSIL

PURE FUSED SILICA

FILTERING & IGNITION CRUCIBLES

Each of these Vitreosil crucibles has a sintered quartz porous disc fused into the base and this obviates the use of a separate filtering mat. Filtering, ignition and weighing of precipitates can be carried out in the same vessel, saving time and ensuring maximum analytical accuracy. Filtering discs are carefully tested for porosity, and crucibles of tall form or conical shape are available in a standard range of sizes from 5 to 50 mls. capacity. A leaflet giving full details of sizes and prices is available on request.

A BRITISH PRODUCT

SERVING CHEMICAL INDUSTRY

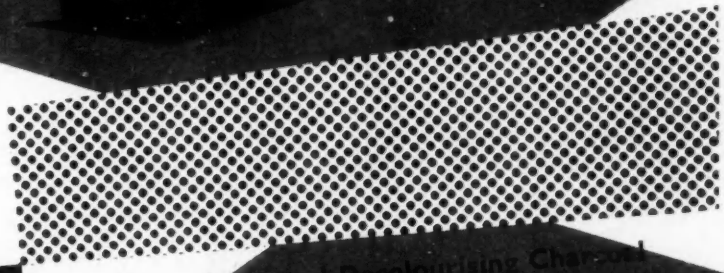
TSL

THE THERMAL SYNDICATE LTD

P.O. BOX NO. 6, WALLSEND, NORTHUMBERLAND
Telephone : Wallsend 6-3242.

London : 12-14 Old Pye Street, Westminster, S.W.1.
Telphone : Abbey 5469.

Ciech



CARBOPOL

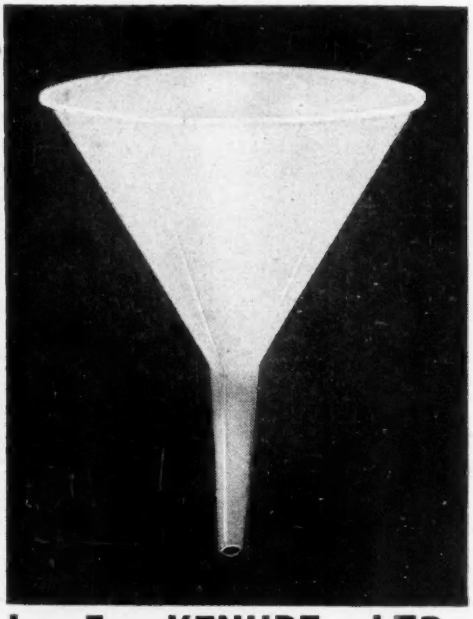
Activated Decolourising Charcoal
High absorption capacity
High filtration capacity
Low operating cost
High efficiency
Simplicity in use
High degree of purity
are the leading features of
"CARBOPOL"
activated decolourising charcoal

We offer an extensive range of activated charcoal—acid, basic and neutral—in powder form or grains ranging from 0.6 to 40mm, for purifying, decolourising and deodorizing liquids; also in the form of pressed granules and fine grains for the absorption of gases.

"Carbopol" activated charcoal can be strictly adapted to customers' actual requirements and to all purposes for which activated carbon is used

Detailed leaflets sent on application to the Sole Exporters—

"CIECH" Ltd.
Exporters and Importers of Chemical Products
12 JASNA STREET, WARSAW 10
POLAND P. O. BOX 343
Telegrams: Ciech, Warsaw Telephone 68



Non-Breakable POLYTHENE FILTER FUNNELS

Made in the following sizes:-

1½" 2½" 3½" 4½" 5½" 6½" 8½"

(Two largest sizes are not subject to P.T.)

Proof against:-

ACIDS · ALKALIS · OILS · SPIRITS

YOUR ENQUIRIES ARE WELCOMED

J. F. KENURE LTD., FELTHAM, MIDDLESEX

Phone: Feltham 2604-5-6

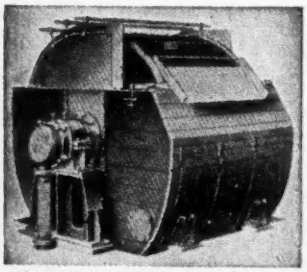
UNIFLOC REGD. TRADE MARK

Plant for the Chemical Industry

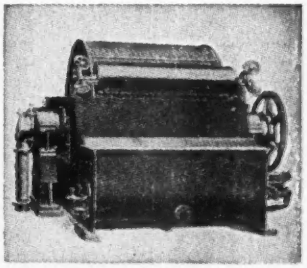
for ACID NEUTRALIZATION, CLARIFICATION OF LIQUIDS, DEWATERING OF SLUDGES, EFFLUENT PURIFICATION, FILTRATION AND FLOCCULATION, PICKLING LIQUOR TREATMENT, PURIFICATION OF TRADE WASTE SEDIMENTATION AND THICKENING, SEPARATION OF SOLIDS FROM LIQUIDS, SODA RECOVERY. WET MATERIAL HANDLING

including

AGITATORS CAUSTICIZERS, CLARIFIERS, CLASSIFIERS, CONVEYORS, DEWATERING MACHINES, ROTARY, VACUUM FILTERS, SAND WASHERS, SLUDGE PUMPS, THICKENERS, etc.



Rotary Pulp Washing Machine, with Pitch Pine Trough, Wash Gear and Scraper Knife



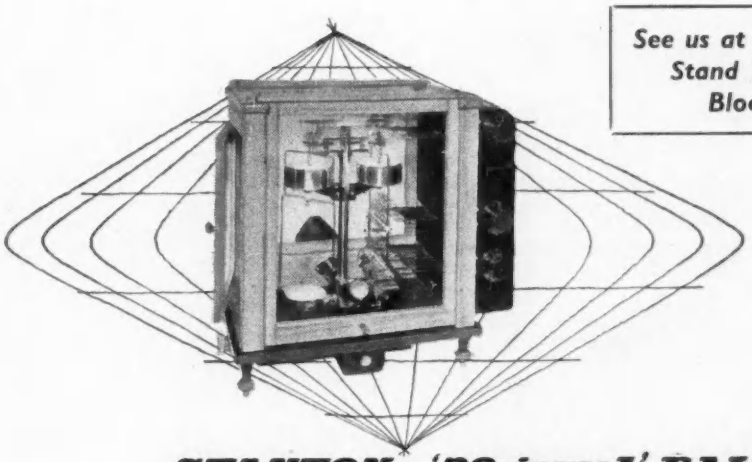
Rotary Vacuum Filter, with Take-off Roller and Repulper

UNIFLOC LIMITED

— SWANSEA —

Phone : Swansea 55164 (3 lines)
Grams : Unifloc, Swansea

See us at the B.I.I.E. Stand No. 26, Block A



STANTON '20-jewel' BALANCES

The finest in the world

Made with traditionally British craftsmanship, all aperiodic chemical and micro-balances are now fitted with completely jewelled arrestments where all points of contact are between agate surfaces.

Stanton are the only British balances featuring this refinement.

STANTON '20-JEWEL' BALANCES ARE UNSURPASSED FOR—

Smooth set-off • Reproducibility • Precision • Speed of weighing

Compare also the following additional features which together make Stanton Balances the finest precision instruments of their kind • Stainless steel pans, pan wires, weight hooks and rider slides • Stainless steel weights • Easy-to-read graticule images • Smooth fingertip weight-loading control • Illumination with green filter and controlled by micro-switch • Finely polished mahogany cases.

Key to Diagram:

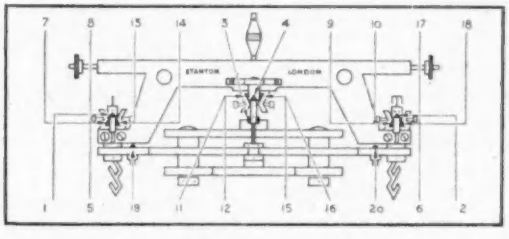
Nos 1, 2, 3 Optically flat sapphire planes

Nos 4, 5, 6 Selected agate knife edges

Nos 7, 8, 9, 10, 11, 12 Polished agate cones

Nos 13, 14, 15, 16, 17, 18 Polished agate points

Nos 19, 20 Polished agate domes

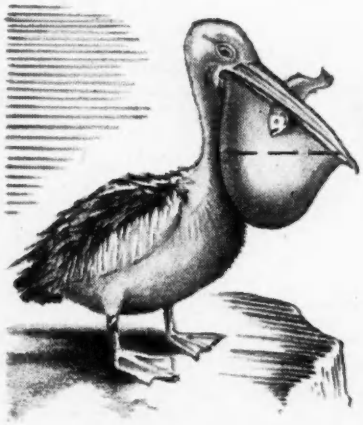


Send for full details or ask for our technical representative to call.

STANTON *precision balances*

STANTON INSTRUMENTS LTD., 119, OXFORD STREET, LONDON, W.1. Tel: GERrard 7533-4

No. 2 of a series

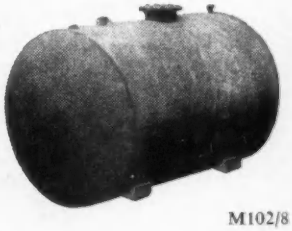


Giving good storage..

* Endowed by nature with a prodigious pouch, a pelican has nothing to worry about in the way of storage problems, merely putting surplus fish into his pouch until required. Modern plant, however, demands something more substantial than an expansible pouch to solve its storage problems, but in this respect Markland Scowcroft Ltd. can help.

Steel-plated and electrically welded, our storage vessels can be treated for special use, and can be used for storing solvents and virtually every fluid. Not only specialising in storage vessels, we can be depended upon for first-class—Steel Chimneys, Ducting, Hoppers, Bunkers and all Mild Steel Fabrications. Simply write, 'phone or call for further details.

IMMEDIATE DELIVERY OF STOCK SIZES
Work performed to Lloyd's Class 2 Specification.



Markland Scowcroft Ltd

COX GREEN WORKS, BROMLEY CROSS, NR. BOLTON Phone EAGLEY 600 (4 lines)

M102/8

TECHNICAL . FICTION . GARDENING . THE THEATRE . MUSIC . HISTORY . ECONOMICS
POLITICS . MEMOIRS . TRAVEL GUIDES . FAMILY AND COOKING CHILDREN'S BOOKS

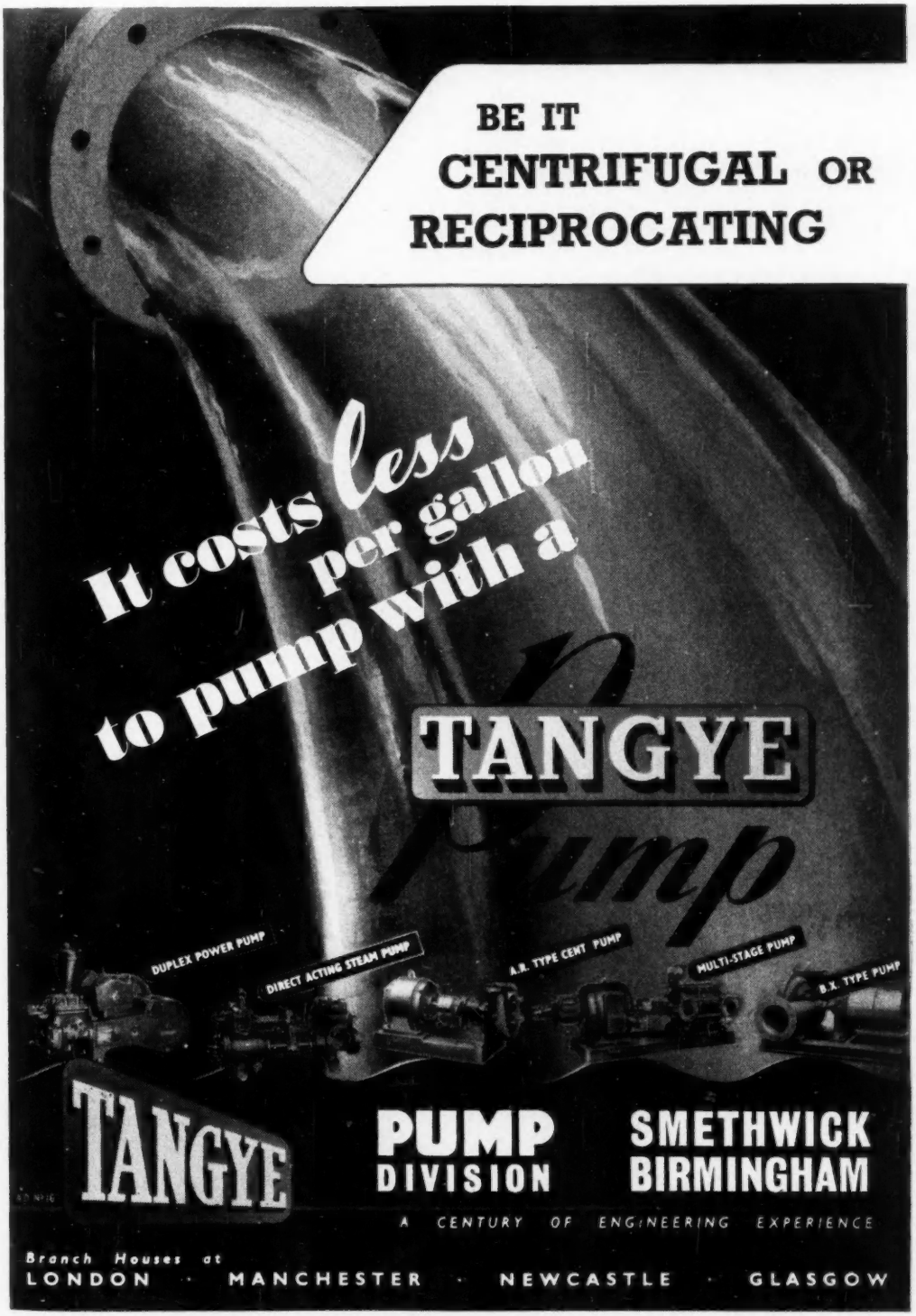
A Complete Cataolgue

of Books Published by

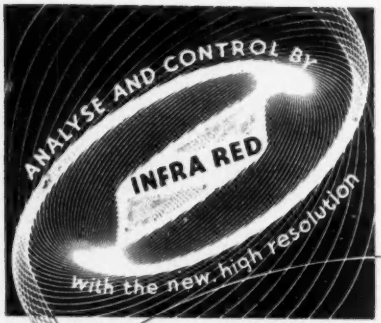
ERNEST BENN
BENN BROTHERS
WILLIAMS AND NORGATE
QUALITY PRESS
LINDSAY DRUMMOND

is obtainable from Ernest Benn Limited

BOUVERIE HOUSE . 154 FLEET STREET LONDON . EC4

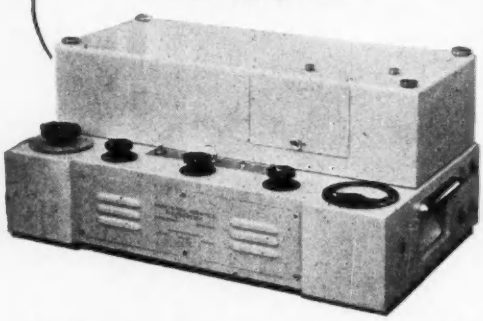

BE IT
CENTRIFUGAL OR
RECIPROCATING
It costs less per gallon to pump with a
TANGYE
Pump
DUPLEX POWER PUMP
DIRECT ACTING STEAM PUMP
A.R. TYPE CENT PUMP
MULTI-STAGE PUMP
B.X. TYPE PUMP
TANGYE
PUMP DIVISION
SMETHWICK BIRMINGHAM
A CENTURY OF ENGINEERING EXPERIENCE
Branch Houses at
LONDON · MANCHESTER · NEWCASTLE · GLASGOW

AD 16



Mervyn·N.P.L.

INFRA·RED SPECTROMETER



NOW—Infra-red analysis enters a new phase with the development of this Mervyn engineered instrument using Merton—N.P.L. diffraction gratings.

Here is the long awaited high resolution instrument for the 1 μ—4 μ region. Of great stability, it reads percentage transmissions direct.

USING A COMPLETELY NEW ELECTRONIC COMPENSATING SYSTEM

This versatile instrument is compact and simple to operate. Has many applications in the manufacture of petroleum products, plastics, detergents, pharmaceuticals and other processes where the high cost of contemporary equipment has restricted the use of Infra-Red techniques.

Send for full information to : Dept. IS/2

MERVYN INSTRUMENTS

ST. JOHN'S, WOKING, SURREY

Telephone: WOKING 2091

PB. Ola

FOR

ALL CLASSES OF DETERGENT AND BLEACHING OPERATIONS

SODIUM METASILICATE

SODIUM SESQUISILICATE

SODIUM ORTHOSILICATE

HYDROGEN PEROXIDE

(ALL STRENGTHS)

SYNTHETIC AND ALL-PURPOSE DETERGENT COMPOUNDS

SEND PARTICULARS OF YOUR DETERGENT AND BLEACHING PROBLEMS TO

ALCOCK (PEROXIDE) **LTD**

LUTON - BEDS

Telephone : LUTON 4900 (3 lines)

Telegrams : Peroxide, Luton

Telephone : Clissold 1234

55/60

THERMOMETERS

* British Made throughout.
* Mercury, Mercury Thallium and Fluid Types.
* Standard Thermometers of the highest accuracy covering a range of −200°C. to +520°C.
* N.P.L. certificates supplied with any type required.
* Manufacturers to B.S.S., I.P., A.S.T.M., S.T.P.T.C., etc., specifications. Also to customer's own B.P.
* Obtainable from all the principal Scientific Instrument and Laboratory Furnishers.

by

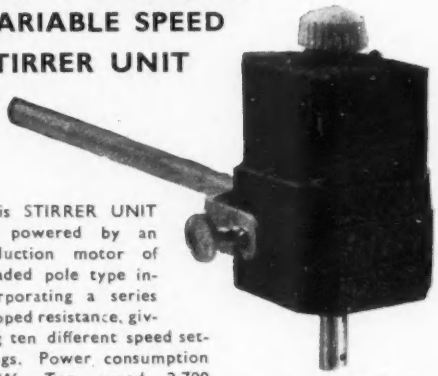
B. BLACK & SON LTD

Established over 100 years

180 Goswell Road, London, E.C.1

Phone: Clerkenwell 2908 *Grams:* Gasthermo, Barb, London'

THE PICKSTONE VARIABLE SPEED STIRRER UNIT



This STIRRER UNIT is powered by an induction motor of shaded pole type incorporating a series tapped resistance, giving ten different speed settings. Power consumption 40W. Top speed 2,700 R.P.M. Windings designed for hot running, thus motor may be stalled at full current indefinitely. Oil impregnated porous bronze bearings.

£3:10 including packing and post in U.K.

STAINLESS STEEL STIRRING RODS ALSO AVAILABLE

Send order, or request further details, to:

Sole Manufacturers:

R. E. PICKSTONE LTD.

56-60 Islington Park Street, London, N.1

Telephone: CANonbury 6190

. . . a New Mechanical Pestle & Mortar Grinder

HERBERT ALEXANDER & CO. LTD. have pleasure in introducing a new Mechanical Pestle & Mortar Grinder incorporating all the essential features required for the efficient grinding and pulverising of material samples.

The machine is of a neat, compact, and pleasing design, occupying bench space of approximately 24½ in. by 10½ in., with an overall height of 18 in.

The fast and efficient grinding of material is ensured by the contra-rotating Pestle and Mortar with a speed ratio of 3:1.

The Driving Mechanism of the Machine is totally enclosed and quiet in operation.

The Mortar (in either agate or high quality hardened steel) has a spherical bowl 3⅛ in. diameter by 1 in. deep and is accommodated in a fully cushioned carrier. The Pestle has a 2-in. diameter head, correctly formed to suit the radius of the Mortar Bowl.

All revolving units are carried in grease-packed deep-groove ball bearings.

Standard machines are equipped for an electrical supply of 230 Volts, Single Phase, 50 Cycles, but other supply characteristics can be incorporated as required.

For further Particulars write to :—

HERBERT ALEXANDER & CO. LTD. Charmouth Street, Leeds, 11

Telephone : LEEDS 20655 ***Telegrams : ALEXSON, LEEDS 11***

MODEL 7 Universal AvoMeter

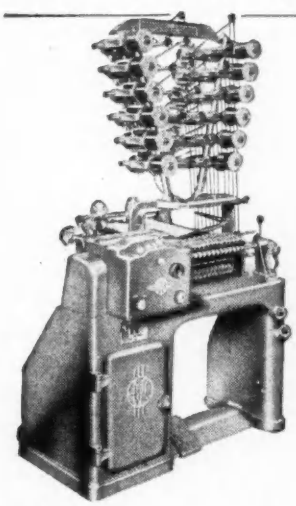
The world's most widely used combination electrical measuring instrument. It provides 50 ranges of readings on a 5-inch hand calibrated scale fitted with an anti-parallax mirror. The movement is effectively damped to facilitate reading. The meter will differentiate between A.C. and D.C. supply, the switching being electrically interlocked. The total resistance of the meter is 500,000 ohms. The instrument is self-contained, compact and portable, and is protected by an **automatic cut-out** against damage through inadvertent application of overload. Power Factor and Power can be measured in A.C. circuits by means of an external accessory (the Universal AvoMeter Power Factor and Wattage Unit).

CURRENT: A.C. and D.C. 0 to 10 amps.
VOLTAGE: A.C. and D.C. 0 to 1,000 volts.
RESISTANCE: Up to 40 megohms.
CAPACITY: ·01 to 20 mFds.
AUDIO-FREQUENCY POWER OUTPUT: 0—2 watts.
DECIBELS: —25Db. to +16Db.

Various accessories are available for extending the wide ranges of measurements.

£19:10s.

Size: 8" × 7¼" × 4½"
Weight 6¾ lbs. (including leads).



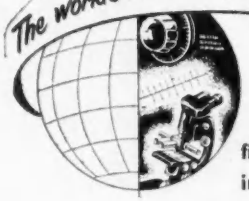
The 'DOUGLAS'
Fully Automatic
MULTI-WINDER

Specially developed for the high-speed production of large quantities of coils with or without paper interleaving. It will produce round, square or rectangular coils up to 6 inches each in length and up to 4½ inches diameter. As many as twelve smaller coils can be wound simultaneously within the total available winding length of 15 inches at headstock speeds of between 600 and 2,000 r.p.m. The machine is fitted with a rapid-change gearbox which provides 153 different traverse speeds. It reduces the setting-up time and also enables adjustments to be made for varying diameters of wire which may occur during the winding of a batch of coils.

Twenty-seven different Coil Winders and Taping Machines are illustrated in our enlarged Catalogue, a copy of which will be sent to interested executives on application.

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.
AVOCET HOUSE · 92-96 VAUXHALL BRIDGE ROAD · LONDON · S.W.1. 'Phone : VICtoria 3404 (9 lines)

The world's most comprehensive display of Instruments



BRITISH INSTRUMENT INDUSTRIES EXHIBITION

Nowhere else will you find an exhibition specializing in instruments and instrumentation, of the size and scope of

THE BRITISH INSTRUMENT INDUSTRIES EXHIBITION

Every field of instrumentation in Power Supply, Industry, Medicine, Research and Education is covered. You will see all classes of temperature pressure and flow controllers for industrial use, electrical measurement and control, complete equipment for sea and air navigation and land surveying, scientific instruments and equipment for all laboratories, electronic instruments for all applications and precision equipment in such diverse fields as metrology, photography and engineering design.

The products of the British Instrument Industry will be conveniently displayed all on one floor ! Industrialists will find a visit to the exhibition extremely rewarding.

F. W. BRIDGES & SONS LTD., Grand Buildings, Trafalgar Sq., London, W.C.2

Phone ; WHITEHALL 0568

Telegrams & Cables ; SEGDIRB, RAND, LONDON.

Make your reservations now

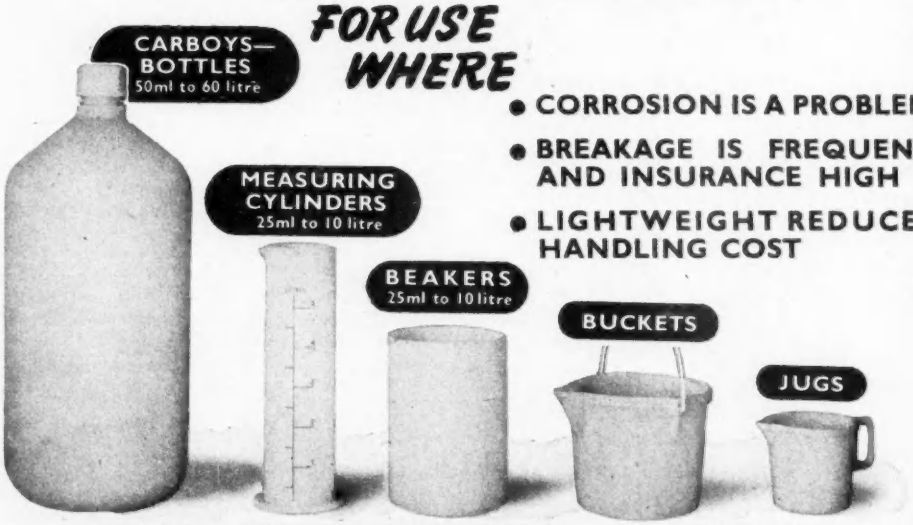
During this exhibition, IPEX—the 10th International Printing Machinery and Allied Trades' Exhibition opens at nearby OLYMPIA. Book your hotel accommodation now. For further details or an official catalogue of the British Instrument Industries Exhibition when published, write to the Organizers.

X-LON PRODUCTS

MADE OF POLYTHENE • P.V.C. AND TERYLENE

FOR USE WHERE

- **CORROSION IS A PROBLEM**
- **BREAKAGE IS FREQUENT AND INSURANCE HIGH**
- **LIGHTWEIGHT REDUCES HANDLING COST**



TANKS AND DUCTING • SPECIAL FABRICATION

X-Lon House, 48 Gillingham Street, London S.W.1. VICtoria 7412/5

ORGANIC REAGENTS FOR METALS
AND OTHER REAGENT MONOGRAPHS
H&W
A new edition
Hopkin & Williams Ltd. announce a new edition of "Organic Reagents for Metals". This publication, which was first issued in 1933, now appears under the title "Organic Reagents for Metals and other Reagent Monographs", 5th edition. Volume 1, which is now available, consists of twenty-seven Monographs, fourteen of which have already been issued individually, the remaining thirteen Monographs appearing for the first time in this volume. Following the publication of Volume 1, a further series of individual Monographs will be issued from time to time and these will eventually appear in a collective form as Volume 2.
"Organic Reagents for Metals and other Reagent Monographs" 5th Edition Vol. 1 (1955) 15/- nett, post free.
HOPKIN & WILLIAMS
LIMITED
Manufacturers of Fine Chemicals for Research and Analysis.
CHADWELL HEATH, ESSEX, ENGLAND

H&W

LATEST PUBLICATION

LABORATORY FURNISHERS

CHEMICALS and ACIDS
for
LABORATORIES & WORKS
SCIENTIFIC GLASSWARE
and
APPARATUS

KERNICK & SON LTD.
9-13 MOIRA TERRACE, CARDIFF
Phone & 'Grams: Cardiff 26128 (2 lines)

GUM ROSIN
(ex U.K. stock)
SODIUM CHLORATE
POTASSIUM CARBONATE
POTASSIUM NITRATE
(Double Refined)

Enquiries Invited :—

MERCANTILE HOLDING & TRADING CO., LTD.
Blomfield House,
52 New Broad Street,
London, E.C.2

Telephone : LONDON WALL 5951-3
Telegrams : MERCTRAD LONDON
Telex : 8520

HAVE YOU A WORKS FIRE BRIGADE?

Fire Loss in the United Kingdom runs to some £25,000,000 per annum, the bulk of which occurs in industrial concerns.

FIRE PROTECTION REVIEW, recognised as the Technical Newspaper of the Industrial Fire services, carries month by month, many features and articles of special value to executives in any way connected with industrial Fire protection and extinction and safety measures.

Fill in the form for a free specimen copy and subscription details to :

FIRE PROTECTION REVIEW
BENN BROTHERS, LIMITED,
Bouverie House, Fleet Street,
London, E.C.4, England

Please send, without obligation on our part, a specimen copy of FIRE PROTECTION REVIEW and details of subscription :—

For attention of.....
Name of Firm.....
Address .....
.....
Date..... .....

Platinum *laboratory apparatus*

The century-long experience of Johnson Matthey in both the manufacture and use of platinum apparatus, coupled with craftsmanship of the highest order, provides a guarantee of quality in all JMC platinum ware. Good design, close attention to dimensional accuracy and the highest standards of finish are combined to produce units excellently matched to their duties and of robust construction for long, trouble-free service.

Specialised Products of

Johnson Matthey

Catalogues 1710 and 1720 are free on request

JOHNSON, MATTHEY & CO., LIMITED, HATTON GARDEN, LONDON, E.C.1

Telephone: HOLborn 6989. Vittoria St., Birmingham 1. Telephone: Central 8004. 75-79 Eyre St., Sheffield 1. Telephone: 29212

Now in preparation

The 1956 Edition of

THE CHEMICAL AGE YEAR BOOK

THE BUYERS' GUIDE SECTION
is becoming the standard reference throughout the world for buyers of chemicals, chemical plant, equipment and instruments in use wherever chemistry is applied to industry.

THE 1956 EDITION BUYERS' GUIDE
will be still further enlarged and manufacturers' and suppliers' names will appear under

SOME 3,500 COMMODITY HEADINGS
listed alphabetically.

If you have not yet sent your instructions please write now for Entry Form to :-

THE CHEMICAL AGE

154 FLEET STREET - LONDON, E.C.4

or telephone **CENTRAL 3212.**

ESTABLISHED 1929

RICHMOND WELDING CO.

PRESSURE VESSELS
IN
STEEL, STAINLESS STEEL, ALUMINIUM, COPPER, ETC.

METAL SPRAYING
WELDING AND REPAIRS TO ALL METALS

RICHMOND ROAD,
BRADFORD, 7 Tel: 25405

SPECIALISTS IN

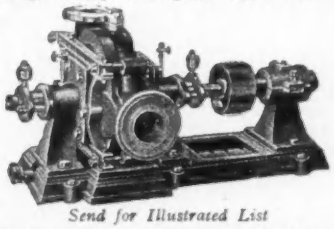
BULK LIQUIDS
TRANSPORT

Acids • Oils • Spirits and General Chemicals

Harold Wood & Sons, Ltd.
Wormald Street, Heckmondwike
Telephone: HECKMONDWIKE 1011/5
Telegraphic Address: "Transport" Heckmondwike
London Office: 22 SOUTH MOLTON ST., LONDON, W.1
Telephone: Mayfair 6060

"Fullersite" SLATE FILLER
for
BITUMINOUS PRODUCTS, PAINTS, MOULDED RUBBER GOODS, PHARMACY, CERAMIC WARE
apply:—**PENRHYN QUARRIES LTD.**
Port Penrhyn, Bangor
N. Wales

For all kinds of Acid Lifting, Haughton's Centrifugal and Plunger Pumps in Regulus and Ironac Metal



Send for Illustrated List
HAUGHTON'S METALLIC CO. Ltd.
30, ST. MARY-AT-HILL, LONDON, E.C.3

KEEBUSH

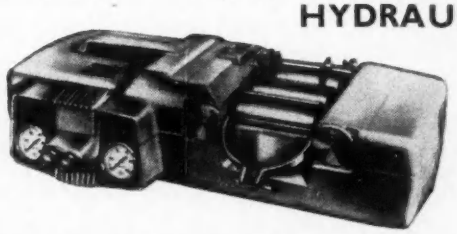
Keebush is an acid-resisting constructional material used for the construction of tanks, pumps, pipes, valves, fans, etc. It is completely inert to most commercial acids; is unaffected by temperatures up to 130°C; possesses a relatively high mechanical strength, and is unaffected by thermal shock. It is being used in most industries where acids are also being used Write for particulars to—

KESTNER'S
5 Grosvenor Gardens, London, S.W.1

COTTON BAGS
AND
LINERS for SACKS, BARRELS and BOXES

WALTER H. FELTHAM & SON., LTD.
Imperial Works, Tower Bridge Road, London, S.E.1

HYDRAULIC TRIPLE ROLL MILL
with Self-contained Motor and Chrome Skin Rolls



Designed for large scale Laboratory work and the production of Cosmetics, Pastes, Ointments, etc.

HOLMES BROTHERS PAINT MACHINERY LIMITED
38 Victoria Street, London, S.W.1. Telephone: ABBey 1911

--the new range is of special importance to all users of Volumetric Laboratory Glassware, and, in particular, to Food Research and Food Manufacturers' Laboratories, Public Analysts, etc., whose special requirements--Lead - and Antimony-free glassware--initiated the developments that produced the new techniques employed.

These successful techniques provide indestructible* graduations that give maximum readability throughout the lifetime of the apparatus.

This is achieved by a vertical translucent amber glass band (an integral part of the glass) covering the right-hand half of the figured scale which is clearly etched into the glass and through the amber band. The graduations are NOT filled in as they are shown in sharp relief, so providing extremely clear readings at all times.

The base of the meniscus no longer requires back shading since it is clearly defined by the bisecting amber band, as are the graduations themselves.

If you are unable to visit The British Instrument Industries Exhibition, Earls Court, London, June 28th--July 9th, 1955, where this new glassware will be shown on Stand 12A, please write to the Sole Manufacturers of "E-MIL" AMBER LINE, H. J. Elliott, Ltd., "E-MIL" Works, Treforest Industrial Estate, Glam, Gt. Britain. They will be pleased to send you a copy of their new Catalogue No. C.7, fully describing "E-MIL" AMBER LINE, and their latest range of Laboratory Glassware products.

*except by Hydrofluoric Acid, abrasive, or chemical action such as attacks the glass itself.

Volume LXXII
Number 1876

The Chemical Age

Established 1919

The Weekly Journal of Chemical Engineering and Industrial Chemistry

BOUVERIE HOUSE · 154 FLEET STREET · LONDON · EC4

Telephone : FLEET STREET 3212 (26 *lines*) *Telegrams :* ALLANGAS · FLEET · LONDON

CONTENTS . 25 JUNE 1955

Quantitative Paper Chromatography	1421
Recent Developments in Titrimetry	1423
Dunlop's Synthetic Rubber Plans	1426
Instrumental Particle Size Analysis	1427
'Enforced Order' Mixer	1435
Laporte Industries Ltd. Report	1441
The British Instrument Industries' Exhibition	1443
New Laboratories at Liverpool University	1455
Canadian Ammonia Plant	1456
Analytical Chemistry of Nb & Ta	1457
Notes on Microtechnique for the Industrial Chemist	1463
The Chemist's Bookshelf	1467
Home News Items	1470
Overseas News Items	1472
Personal	1474
British Chemical Prices	1476
Chemical & Allied Stocks & Shares	1484
Law & Company News	1486
Next Week's Events	1488

Editor : E. Arnold Running *Publisher & Manager : John Vestey*

MIDLANDS OFFICE :
Daimler House, Paradise Street, Birmingham
Phone : Midland 0784/5

SCOTTISH OFFICE :
116, Hope Street, Glasgow, C.2.
Phone : Central 3954/5

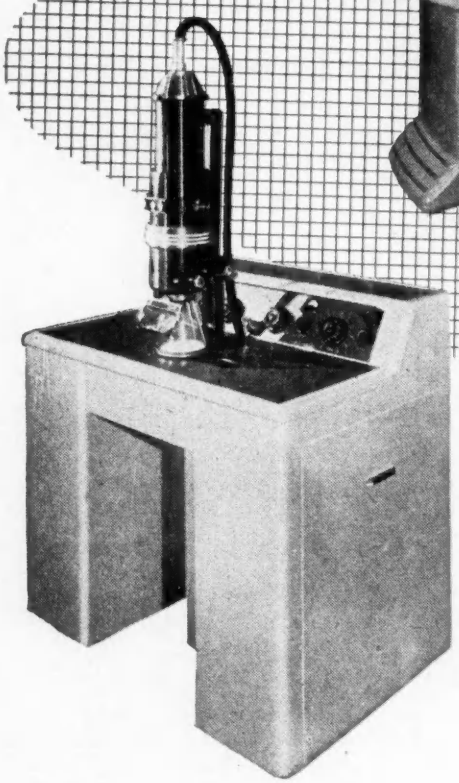
LEEDS OFFICE:
Martins Bank Chambers
Park Row, Leeds, 1
Phone : Leeds 22601

SINGLE COPY 1/- (BY POST 1/3) ANNUAL SUBSCRIPTION 42/-

D

Electron Microscopes by Philips

100 kV Electron Microscope: magnification continuously variable, 1,000 to 60,000 diameters. Two models available—better than 50 Angstrom units or better than 25 Angstrom units.



75 kV Electron Microscope: magnification continuously variable, 1,500 to 15,000 diameters. Resolving power better than 100 Angstrom units.

Compact, simple to control, completely safe to operate—these instruments open new fields in sub-microscopic research. A special feature is their "oscillating beam" device, which ensures immediate and exact focusing.

Send to-day for literature giving complete information.

Products of N.V. Philips, Eindhoven, Holland.

PHILIPS

PHILIPS ELECTRICAL LTD

X-RAY DIVISION

CENTURY HOUSE · SHAFTESBURY AVENUE · LONDON · W.C.2

(PXI0070D)

Instrumentally

PROBABLY one of the best-known university text-books, at any rate among those that are now to be regarded as classic old-timers, is Alexander Findlay's 'Practical Physical Chemistry', which appeared initially in 1906, and within its first 20 years ran through three new editions and eight new impressions. Physical chemistry is dominated by measurement—and with much more diversity of measurement—than other branches of chemistry. Looking through the fourth edition of Dr. Findlay's classic, which means we are stepping backwards into the chemical scene of 30 years ago, it is unusual to find any piece of apparatus requiring special description and illustration also having British origin. The Pulfrich refractometer in the section on optical measurements is made by Zeiss of Jena though footnotes to one of the subsequent impressions mention that two British apparatus firms also produce Pulfrich refractometers; the Lippich polarimeter described is a product of Schmidt and Haensch. A stand —simply a specially designed laboratory stand!—for holding a capillary electrometer is from Fritz Köhler, of Leipzig. Calorimeters for thermo-chemical determinations, three forms of which are described in detail, are all from this same Leipzig firm. With perhaps one exception, only the simpler pieces of special apparatus described in this text-book in its 1923 edition and 1923/28 impressions are products of the British scientific apparatus industry.

As we remarked a year or so ago (see THE CHEMICAL AGE, 1954, **70,** 1429), 'we need not go back very far into history to find a time when British needs for apparatus and instruments were heavily met by imports, particularly from Germany'. The first World War shattered this weakly dependent situation. In 1914 the British apparatus and instrument industry was little more than a minor trade. It had to be expanded during that war in order to meet the entirely new demands of the Services, let alone to provide replacement instruments for research and industrial laboratories. By 1918 a small trade or craft had grown into a new and promising industry. Its further expansion was rightly protected by the post-war Government with the introduction of a Key Industry Duty. Gradually the prominence of European instruments in British laboratories faded.

The most constructive act in the development of this essential industry was the formation in 1918 of the British Scientific Instrument Research Association. Of all the industrial research associations jointly parented by industry and the DSIR, this is the oldest still in existence. Financial data given in the last DSIR Annual Report indicate that the industry is providing at least £9,000 per year in addition to the contracted minimum sum for shared support. In our recent reviews of the DSIR Report (see THE CHEMICAL AGE, 1955 **72,** 721) we pointed out that for most research associations the terms for official financial support were being stiffened, larger sums being required from collective industry to qualify for the block grants made by the DSIR. It may be regarded as a token of the national importance of the instrument industry that the new terms

for SIRA have not been tightened to the same degree as new terms for some of the other associations. A block grant of £35,000 per annum is still offered, the only difference being that £17,500 instead of £15,000 is required from the industry; the terms for additional shared support remain the same, £100 per £100. It is necessary only to read the two or three pages devoted in the DSIR Report to a summary of SIRA's current activities to appreciate the width of impact its research possesses. In few fields of investigation and development is it so certain that effort undertaken for one specific purpose will be rewarded with a harvest of other applications.

One point about SIRA might be noted. The view has now developed that the actual design of instruments is no longer a primary SIRA task or activity. This may seem paradoxical, but instrument design—at any rate for particular tasks—has become one of the standard and effective activities of most industrial research associations and major research centres. It is possible for SIRA to devote more and more of its effort to fundamental research and to studying entirely new methods of measurement. Apart from the obvious advantage in using a specialised research centre for more and more fundamental work, this new trend is a most satisfying sign of instrumental strength in British science, for it shows that design 'know-how' is now fairly widely distributed.

In scarcely more than 35 years the British picture in this basic scientific field has been completely reversed. Where once most specialised instruments and far too much quite simple apparatus had to be imported, now our own instrument and apparatus industry can provide the main bulk of home needs and it also exports a substantial part of its output. How much the export trade of the past 10 years owes to the lessened production and competition of Post-Hitler Germany is difficult to estimate—but the same capital-lettered question lurks behind post-war British export statistics for other fields in which Germany was formerly so powerful, e.g., dyes and pharmaceuticals. As in these other fields, so in this the question will find its answer in the near future, for the revival of industrial Germany is no longer futuristic. Salesmanship as well as efficiency in design and production must play a significant part in holding our new-won share in world trade. Instruments and apparatus are exceptionally suitable for display at exhibitions, and, collectively or individually, the British industry should be powerfully represented at all major trade fairs or exhibitions abroad. Catalogues, always an expensive feature of this industry, should be both fully detailed and modern in lay-out. From what was seen of German instruments at a recent Continental fair, British manufacturers need not be ashamed to show their products in the opposition camp. Export trade that has been built up as an accompaniment to this achievement should not be lost by any form of default.

There are present signs that our overseas sales are meeting stronger competition, particularly in India and Scandinavia. However, figures for the first four months of 1955 for export sales of scientific glassware show that the 1954 level of trade is being maintained. Part-year assessments are not always reliable, but for what it is worth there is an indication of slight expansion—1954, £614,340; 1955 to end of April, £213,618. On the basis of 1954 trade, the four months' figures would be £204,664. If less specialised scientific glassware sales are included, such as blanks, the 1955 sales-level is improved more decisively for an overall increase in sales-value of nearly 20 per cent is then shown. But competition seems to be more powerfully revealed by 1955 sales-figures for glassware instruments, e.g., microscopes, thermometers, meteorological equipment. For these the sales in the first four months of 1955 fall slightly below the 1954 rate. This may be an indication that Germany is gaining trade where instruments are concerned, but not so markedly in the less complex field of standard apparatus. Yet these are minor woes if, indeed, they represent woes at all. The far more important fact is that in the first four months of 1955 the export-value of British scientific glassware was almost five times the total value for the whole of 1938. Our imports of scientific glassware in 1954 were only one-quarter of the 1938 figure, about £19,000 as against £79,000. There is the real measure of a vital industry's progress.

Notes & Comments

Skin Protection

A NEW YORK medical paper is discussed in *Chemical & Engineering News* (1955, **33,** 2,302). It deals with the skin irritation caused by soaps and detergents. We could not help thinking that there are now many people in this country who would question the generality of this approach, for here the expansion in use of domestic detergents is said to have brought a substantial rise in cases of dermatitis. With or without sufficient statistical evidence, many doctors in general practice put the blame for increased cases of dermatitis upon detergents; and this verdict is also being given by specialists in skin troubles.

Acid Buffering Agents

THE view taken in the US paper is that the skin is normally protected by a thin film 'mantle' able to maintain skin acidity. People who suffer from skin troubles as a result of soaps or detergents are people whose protective film is sluggish in neutralising the contact-effect of alkalis and certain fatty acid radicals. Of the latter, the lauric acid radical is said to be the most damaging. A successful curative cream, based upon a silicone-acid (15 per cent), is described. Acids such as acetic or citric acid are also included as buffering agents. The cream is used to prevent dermatitis recurrence after normal dermatitis therapy.

Let's Have the Truth

NO ONE who has suffered from dermatitis will feel scornful about a new remedy, but there will be a natural enough feeling that the arrival of a new chemical preparation to cure the effects of other chemicals is not genuine progress. Research that is more fundamental is needed. Have modern detergents caused more dermatitis? If so, which types of detergents have been the most troublesome? Or is some other change in modern life making more individuals skin-allergic to contact-substances? National Health Service statistics for skin trouble cases and treatments over the past three or four years would be a useful guide. It is just as easy to exaggerate this kind of problem as to under-estimate it; the extent to which it exists today should not be left to gossip and surgery hearsay.

Diversity

THE current issue of the Institute of Physics' *Journal of Scientific Instruments* (1955, **32,** 6) provides an excellent opportunity for cross-section surveying instrument technology. A remarkable diversity of both origin and purpose is probably the most vivid impression made. Here are described a centrifuge permitting continuous observation of the spinning tube (from New Zealand); a new Smith bridge for resistance thermometry (from Teddington, Britain); a demountable glass-blown vacuum system for electronic bombardment studies (from Britain); apparatus for measuring cosmic radiation at great sea depths (from Jamaica); a high-temperature, X-ray diffraction, powder camera (from Japan); and a photoelectric switch for optical instruments (from Britain). This seems a rich enough harvest of novelty for a single month. It is also gratifying to see that a specialised British journal is so clearly a forum for world developments. Perhaps one influence in this respect is the award of annual prizes for the best original contributions of the year. Three such prizes are given each year. They are limited to contributors who are not more than 35 years of age; and the winning contributions are chosen by the Board of the Institute of Physics. The money for these prizes comes from SIMA and from the Bowen Trust Fund established by the late William Bowen. Although these prizes in terms of today's money value are not large—one is for 20 guineas and the other two for 15—they provide incentive where so often exceptional work is regarded as a labour of love. Perhaps in other scientific fields we would profit by

having more of these 'best-of-the-year' prize schemes? The prestige of winning open awards of this kind counts more than the cheques. In these days of differential sensitivity, we cannot do too much to encourage younger scientists to feel that their work is worth doing.

Sports' Day

THE Ashton Playing Fields, Woodford Bridge, were again chosen for the annual Sports Fete of Kemball, Bishop & Co., Ltd., held this year on Saturday, 18 June.

A fine afternoon encouraged a good gathering of employees and their families as well as numerous old servants of the company.

After the opening ceremony, performed by the company's chairman, Mr. J. E. Whitehall, the spectators were treated to a varied and entertaining programme of events. In accordance with tradition these were planned to provide amusement for all, as well as giving adequate opportunity to the more athletically inclined to display their prowess. Enthusiasm was promoted by the Inter-Division Challenge Shield which was retained by Factory 12, with a lead of 19 points over last year's runners-up, the Research, Works and General Laboratories.

Besides having their own races, the children enjoyed a show by a ventriloquist and conjurer.

To conclude an enjoyable afternoon, the prizes were presented by Mrs. H. F. Kemball, the wife of the managing director, to whom Mr. J. E. Whitehall proposed a cordial vote of thanks.

Chemical Automation

SPEAKING at the conference organised by the Institution of Production Engineers which ended at Margate, Kent, on Saturday, Mr. F. G. Woollard, a past president of the Institution of Mechanical Engineers, said if Britain refused automation through fear, other manufacturing countries would not.

Mr. A. J. Young, head of the Central Instrument Laboratory of Imperial Chemical Industries, and Mr. I. McCallum, technical superintendent of Esso's Fawley refinery, discussed the application of central electronic control in the chemical industry.

In developing a fully automatic chemical factory, there are three major problems, Mr. Young stressed. At the moment there was no suitably designed and reliable computer, although this would be overcome, he felt; the accuracy of measuring units and the speed of operation of the units available to transmit the measurements to a central 'Master Controller' was quite inadequate; the best operating conditions of a chemical plant were rarely found to be identical with those specified when the plant was started up.

Six Division Display

SIX divisions of Imperial Chemical Industries Ltd. will be exhibiting at the International Water Supply Exhibition which begins in London on 18 July for four days. Alfloc section will deal with two aspects of water treatment; clarification and colour removal, and methods of preventing scale formation and corrosion in hot water systems.

The Plastics Division will display Alkathene small-bore tubing for domestic, industrial and farm water services. A complete range of tubing will be shown, together with fittings, and photographs and diagrams illustrating installation.

Metals Division will show copper tubing for domestic uses; Kuterlon long-length copper tubing for underground services and radiant panel heating, and tube fittings.

The General Chemicals Division will display methods of using liquid chlorine and hypochlorites in sterilising public water supplies by marginal chlorination, chloramination, and by superchlorination and dechlorination.

Salt Division, divided into two sections, features various grades of salt suited for the re-generation of base-exchange water softening plant, and a photographic display.

The Lime Division will exhibit examples of lime and Limbux, and a display of literature describing the use of Limbux in water softening.

Atom Trade Fair

One of the British exhibits at the Atom Trade Fair to be held in Geneva in August will be a self-propelling atomic power station. Among British firms who will exhibit at the Fair are: Babcock & Wilcox, English Electric, B.T.H., G.E.C., and Metropolitan-Vickers.

Quantitative Paper Chromatography

Direct Spectrophotometric Determination of Co & Cu

For a long time analytical chemists interested in chromatography have sought an accurate and rapid method of spot analysis and Dr. Alice Lacourt, Maitre de Conférence à l'Université de Bruxelles, believes that the answer has been found in her laboratories. Dr. Lacourt and Mademoiselle P. Heyndryckx, Licenciee en chimie, are the authors of the following communication which describes their new method of determining chromatographic spots directly on paper :—

QUANTITATIVE paper chromatography is likely to become a general micro analytical method on account of its general applicability and rapidity. Acceleration of the quantitative determination of spots is obtained by direct titration of these on paper with a reproducibility of ± 3 to 4 per cent in the case of molybdenum and vanadium (**1**). Copper, cobalt, nickel (**2**) and chlorides have already been studied as well.

Direct photometry or densitometry in white light has been applied to the measurement of chromatographic spots of vanadium (**3**) revealed with oxine, of phosphorus (**4**), and of cobalt and copper (**2**). The final complex opacity includes a paper opacity that has to be checked millimeter by millimeter before chromatographic development, and the opacity of the piece of paper at the exact place of the spot has to be taken into account. (**5**) This is not practical when the spot travels too far away from the starting line.

More General Application

Direct spectrophotometry on paper of chromatographically revealed spots has more general and practical application. In the first place, a definite wave length can be used for these measurements as when operating on solutions. This wave length is chosen after drawing both absorption curves—i.e. the curve for the complex and the curve for the reagent. It corresponds to the spectrum region where these two curves show the greatest absorption difference.

Organic reagents and complexes are so insoluble in water that very little of them is yielded to this solvent from a strip of paper carrying a given quantity. Therefore, photometric measurements can be carried out by slipping the strip of paper bearing the spot of vaporised reagent between the wall of the usual spectrophotometric cell and a prismatic calibrated glass adapter, with a few drops of water to eliminate air bubbles. Optical densities of vaporised strips with α nitroso β naphthol or rubeanic acid are so reproducible in this way that one can set the apparatus on zero on these evaporated strips. The optical density of the vaporised spot is then measured directly from this zero. *There is, consequently, no need any more to measure blanks, except for controls, and the position of the spot in the chromatogram is of no importance.*

Reference diagrams have been drawn from 0.1 to 3 micrograms of cobalt and copper.

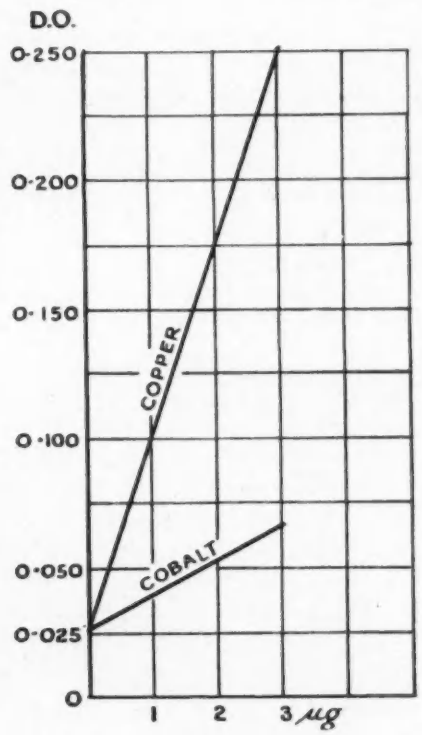


Fig. 1

OPTICAL DENSITY FOR 3μg OF COBALT REVEALED BY MEANS OF α NITROSO β NAPTHOL

	Paper Blank Chromatographed	Paper Blank Chromatographed Evaporated	Mean Values Chromatographed	Mean Values Not Chromatographed
λ = 850mμ .. F = 0.040 mm. ..	0.125	0.130/0.130/0.130 0.129/0.130/0.130 0.130	0.064/0.064/0.063 0.065/0.066/0.065	0.050/0.051/0.050 0.049/0.050/0.041
		M/24 0.1297	M/18 0.064±0.47%	M/18 0.050±0.39%

OPTICAL DENSITY FOR 3μg OF COPPER REVEALED BY MEANS OF RUBEANIC ACID

λ = 660 mμ ..	—	0.010/0.010/0.011 0.011/0.011/0.010	0.245/0.246/0.246 0.246/0.245/0.245	0.239/0.238/0.239 0.240/0.239/0.239
F = 0,095 ..	—	0.009/0.010/0.010	0.246/0.245/0.244 0.245/0.246/0.244 0.245/0.245/0.245 0.246	
		M/18 0.0103	M/18 0.2453±0.01%	M/18 0.239±0.5%

Concentrations can be checked within these limits with a reproducibility within 0.5 per cent.

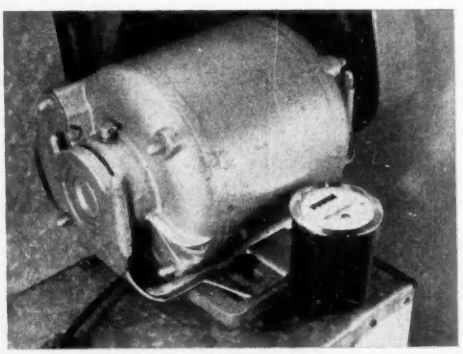
REFERENCES

(1) Lacourt, A., & co-workers, *Comptes Rendus de l'Academie des Sciences de Paris*, 1952, **234**, 2365.
(2) Lacourt, A., & Heyndryckx, P., *Michrochimica Acta*, 1955, **1**, 62.
(3) Lacourt, A., *Michrochimica Acta* (in publication).
(4) Lacourt, A., & co-workers, *Michrochimica Acta* (in publication).
(5) Verbuestel, S., 'Mémoire de Licence en Chimie,' 1955, Faculté des Sciences, Université de Bruxelles'

Process Timing

ACCURATE control of time is often essential to give products of uniformly high quality. If this control is left to an operator, serious errors sometimes arise, leading to defects which it is difficult to trace back to their true source.

Target Services, 6-11 Dorset Close, Gloucester Place, London N.W.1, have introduced the Horameter which is a simple but robust summating counter, registering time in 1/10 hours up to 10,000 hours, when it automatically resets to zero. By using several of these instruments a detailed analysis of process time can be obtained.



Target Services' Horameter

Instead of the more usual synchronous motor, the Horameter incorporates an electromagnet which winds up a clockwork motor at regular intervals. The clockwork only registers when the electromagnet is energised. On plant and machinery powered by steam, gas or oil the instrument can be run off a small battery, control being performed by a switch actuated by the equipment under control.

The Horameter is of conveniently small size and can be mounted by a variety of methods. It is completely sealed and requires no maintenance. Connecting cables of any length can be used, so that a group of the instruments can be placed in a central panel. It is claimed to be resistant to heat, cold, vibration and corrosive atmospheres within wide limits.

Hungary Provides Foreign Plants

According to official government agency announcements, Hungarian engineers are building two drug factories in Bulgaria and have designed an oxygen plant for Argentina and another for China. The equipment for both of the oxygen plants will be supplied from Hungarian sources, it is said. It is also reported that China and Indonesia have both requested plans for fertiliser factories from Hungarian enterprises and that plans for cement factories have been supplied to Iraq, Syria and Poland. Hungarian engineers are said to have planned the dust extraction and ventilation equipment for a large cement works in Uruguay.

Recent Developments in Titrimetry

Symposium at Minneapolis

DESPITE advances in analytical instrumentation, titration methods of analysis seem to be increasing in value and in use. This was emphasised by Philip J. Erving, University of Michigan, in a paper presented at a symposium on titrimetry, held at Minneapolis, Minn., under the auspices of the Division of Analytical Chemistry and *Analytical Chemistry*.

The analytical operation of titration, it was stated, has been greatly favoured in recent years by a more comprehensive view of the chemistry of the titration reaction and by the instrumentation of the process itself. The former has resulted in the development of new titrants and accessory reagents, and in a more considered use of media for titration. The latter has increased the means of detecting the equivalence point, and has indicated the possible complete automatisation of the titration process. (The development of automatic titrators was reviewed in THE CHEMICAL AGE, 1954, **70**, 1441-6).

As an example of the versatility of titration techniques, Elving described a procedure developed for the analysis of a lead alloy suitable for the long-life stand-by batteries needed in telephone systems. The method utilised the fact that calcium and antimony form a solid phase insoluble in lead. The phase has a composition approximating Sb_2CA_9. The titrant was a lead alloy containing one per cent antimony. It was measured by moulding the antimony-lead alloy in pellets of known weight, so that the actual measurement simply involved counting the number of pellets added to the sample.

Equivalence Point Detection

The detection of the equivalence point in the reaction depended on the striking differences in surface appearance of lead alloy containing very low percentages of calcium. Lead containing 0.004 per cent Ca exhibits a brilliant lustre, which appears dark under oblique illumination, except at the edges. Lead containing 0.008 per cent Ca has a surface which is almost completely covered by a grey film, while lead containing 0.006 per cent Ca has an appreciable grey film on the surface. In practice, known amounts of sample are removed from the manufacturing kettle. Varying numbers of pellets corresponding to the range of calcium content expected are added to the different ladles and the mixtures are stirred for a few seconds. The contents of the ladles are chilled by being poured into moulds and the surface appearances are noted. The end-point is taken to be a faint trace of grey corresponding to an untritrated calcium residue of 0.005 per cent. The calcium percentage is then read from the linear calibration curvex showing its relationship to the amount of antimony added. The precision is within $\pm$ 0.002 per cent in the range up to 0.11 per cent calcium; the method is applicable in the range of 0.005 per cent to 20 per cent calcium.

May Serve as Prototype

The view is expressed that this method might well serve as the protoype for the development of other methods of non-ferrous alloy analysis.

Non-aqueous media have long been used in titration. In this connection the most important change in recent years has been recognition of the possibilities inherent in the use of so-called non-reactive and reactive media to enhance and to differentiate the degree of acidity. Elving suggests that it seems worth-while to investigate other types of titrimetric reactions in non-aqueous media. In particular, the use of complex-forming solvents might aid in securing specificity in redox precipitation or complexation titrations.

The increased use of complexation and precipitation methods of titration is due to the introduction of versatile chelating agents, which can be more or less readily modified to accomplish specific objectives. Elving cites as an outstanding example ethylenediaminetetraacetic acid and its salts and derivatives, which have revolutionised the analytical chemistry of calcium and magnesium, and have had a profound influence on the analytical chemistry of many other metallic elements.

The use of chelating agents in titrimetric reactions was reviewed at the symposium

by A. E. Martell and Stanley Chaberk. These authors point out that the application of monodentate and to some extent bidentate reagents to the titration of metal ions is limited by the formation of lower complexes before a specified end-point is reached and by the fact that complexes made up of a number of particles tend to dissociate considerably at the end-point. By using chelating agents these difficulties are avoided, due to the formation of 1:1 metal chelates involving a rapid change of solution properties at the end-point.

Knowing When to Stop

A point on which Elving lays considerable stress is that, as a rule, the most difficult part of any titration is to know when to stop. The equivalence point is described as the stage in a chemical process at which a stoichiometric or empirically reproducible reaction has been completed. The end-point is some observable phenomenon which may be associated with the occurrence of the equivalence point; e.g., a change in colour of the test solution. In the interests of precision and accuracy it is most desirable that the two should coincide.

Recognition of some external feature, the so-called end-point, has been an important objective in analytical research throughout the past century. The increased application of electrical methods for following titration reactions has not only served to establish new means for end-point ascertainment, but has also been of inestimable value in helping to elucidate the nature of many reactions.

Although conductometric titration at audio-frequencies is at present but little used, a development of the past decade, based on the use of megacycle frequency oscillator circuits, seems to offer considerable opportunity for investigation as a means of equivalence point detection. By a proper choice of oscillator circuit and sample cell it is possible to follow changes in capacity as well as resistance, in which concentration is a prime factor. The application of this technique to organic reactions involving non-ionic species may therefore increase to an appreciable extent the types of reactions suitable for titrimetric measurement. Another potential advantage of high frequency oscillator circuits is that insulated cells are commonly used; i.e., the electrical connections are made to the outside of the cell with no contact between sample solution and electrodes.

Potentiometric and amperometric titrations were discussed by another contributor to the symposium, I. M. Kolthoff, on the basis of voltammetry. Potentiometric titrations at zero current with a specific indicator electrode can be carried out with an outside reference electrode (classical method) or with an inside reference electrode (e.g., tungsten) in oxidation-reduction titrations. They can also be carried out at constant current with one or two indicator electrodes. A mercury electrode is advantageous in the titration of many metal ions. Amperometric titrations can be carried out with one or two indicator electrodes, but in many instances the equipment required is much simpler with one indicator.

Kolthoff concludes that, as far as simplicity, accuracy, speed and sensitivity are concerned, amperometric titrations (with one or two indicator electrodes) have, in general, great advantages over potentiometric titrations. This is especially true when dealing with extremely dilute solutions, which can be titrated much more accurately by the amperometric than by the potentiometric technique, especially when one indicator electrode is used and a suitable potential is employed. In the case of relatively strongly irreversible systems amperometric titration with one electrode is superior to the two-electrode system.

Photometric detection of the equivalence point by following the change in radiant energy absorption has certain advantages in many cases—e.g., in slow or incomplete reaction in the region of the equivalence point.

Photometric Method

Robert F. Goddu and David N. Hume described work at the Massachusetts Institute of Technology to establish the general usefulness and accuracy of the photometric method for the determination of weak acids, which differ in light-absorption characteristics. The technique was studied both theoretically and experimentally, one of the aims being to determine the stringency of the fundamental limitations.

In a photometric titration a property is determined which is directly rather than logarithmically proportional to the concentration of the substance being measured. It seemed reasonable, therefore, to deduce that a sharp break might be observed in these

systems where the change in hydrogen ion concentration would obviously be too small. The high sensitivity of the photometric method makes it attractive *a priori* for the titration of very dilute solutions.

The compounds selected for these studies were for the most part substituted phenols, since these provide a graded series of acids of differing strengths and convenient absorption characteristics. The strong absorption of the phenolate ions in the visible short wave and near ultra-violet was used to follow the course of the neutralisation. It was found that satisfactory end-points were obtainable only if the product of ionisation constant and concentration was equal to or greater than 10^{-12} at concentrations of 10^{-5}M and above. The method has advantages over potentiometric methods when determinations are made in highly dilute solutions and with very weak acids.

Pharmaceutical Applications

A paper by Ernest G. Wollish, Charles W. Pifer and Morton Schmall dealt with the applicability of titration in non-aqueous solvents to the pharmaceutical industry. This method is of particular interest to pharmaceutists, since it permits the rapid assay of a great variety of compounds, both in bulk and in pharmaceutical preparations. Suitable selection of solvents, indicators and titrants frequently permits titration of the desired physiologically active compound, such as the basic or acidic part of a salt, often in the presence of compounds which would interfere in an aqueous medium.

In most cases the organic base of an optically active compound has a larger specific rotation than a salt. Where the angle to be read is of low magnitude, or the quantity to be determined small, or the concentration of the salt in water is limited by low solubility, the following technique has been found advantageous:

Without accurately weighing a sample, an approximate quantity of the salt is placed in a separator. If the optically active compound is an organic base, the aqueous solution is rendered alkaline and extracted once with an organic solvent such as chloroform. An aliquot of the chloroform solution is titrated with perchloric acid in dioxene to a methyl red end-point in order to determine the concentration accurately. A portion of the remaining solution is placed in a polarimeter tube and its rotation observed. In this manner the rotation of an organic base can be measured more precisely, or with its specific rotation known, the optically active compound can be determined.

Chemists almost inevitably associate titration with the addition of one liquor or solution to another. Elving believes that a profitable line of investigation is presented by titrations involving reaction in non-liquid-liquid systems. Another field which has too long been overlooked by chemists is titration of a solid with a gas.

Some years ago W. D. Bancroft and C. E. Barnett (*J. Phys. Chem.*, 1930, **34**, 449) described the measurement of amino groups in a protein sample by adding hydrogen chloride gas to a sample container of constant temperature and volume. The steps in the resulting diagram of equilibrium hydrogen chloride pressure versus amount of hydrogen chloride added per unit mass of the solid indicated the number of different types of amino groups present, on the basis of their relative base strength. Carboxyl groups in the same sample could be similarly titrated with dry ammonia gas.

It is suggested that measurements of this nature could be used to obtain valuable analytical information on various types of complex materials such as natural products and polymeric substances.

New Pipette Washer

UNBREAKABLE, inert, resilient, are the claims made for the Pipette Washing Outfit manufactured by Rediweld Ltd., 15/17 Crompton Way, Crawley, Sussex. Fabricated entirely in polythene, the washer consists of two parts, an outer container measuring 7 in. dia. by 24 in. high, and a basket 5 in. dia. by 22 in. high and a tubular grid at the bottom. The pointed ends of pipettes can rest between the struts of this grid without damage. Cut-outs in the body of the basket allow for easier handling of smaller size pipettes.

If it is necessary to wash pipettes with chrome sulphuric acid a separate outer container of the same dimensions can also be supplied. The pipettes, contained in the basket, are first immersed in the chrome sulphuric acid and then transferred to the washing unit.

Polythene is not damaged by chrome sulphuric acid, but organic solvents or detergents would finally lead to destruction of the material, and their use should be avoided.

Dunlop's Synthetic Rubber Plans

Shortage of Raw Materials Limits Activities

ADDRESSING shareholders at the company's annual general meeting, Lord Baillieu, chairman of the Dunlop Rubber Co. Ltd., said that during the past year the company had continued to take an active interest in the development and application of synthetic elastomers which were being increasingly used in the rubber industry. (See THE CHEMICAL AGE, 1954, **70**, 726 & 1346). New varieties were constantly appearing for study and assessment.

Not on Commercial Scale

'Last year', Lord Baillieu said, 'We announced that work had started on a new synthetic rubber plant at Fort Dunlop. I would emphasise, again, that the production from this plant will be confined to new rubbers for special purposes and the plant is not designed to manufacture established general purpose rubbers on a commercial scale. For the present this is as far as we can go until we are able to see ahead and obtain the necessary basic feed stocks.

'A synthetic rubber plant is itself a converter of two basic raw materials, the principal being wholly derived from, and an integral part of, the oil refining industry; the other from the chemical industry. Until these basic materials are available, therefore, it is not a practical proposition to embark upon a synthetic rubber plant itself. We are, therefore, continuing our discussions with the industries concerned to determine if and when it be practicable and economic, and in what form, to undertake further developments.

'In the meantime, we know that the Government is sympathetic and conscious of our problem. We believe that we shall be permitted to import reasonable quantities of general purpose synthetic rubber which we hope will be sufficient for our requirements for some time to come.'

Continuing, Lord Baillieu said that like the synthetic rubbers most of the textiles which comprised the firm's other major raw materials were also the products of chemical research and engineering. The particular properties required for the specialised industrial uses of rayon, nylon, Terylene, etc., were receiving increasing attention from the fibre manufacturers and the company's own interest was evidenced by the continuous research which had been going on for many years. New laboratories were being constructed by Dunlop Cotton Mills Ltd. to study the treatment and uses of new synthetic fibres, which were being developed rapidly.

Referring to the General Rubber Goods Division of the company, Lord Baillieu said that improvement in materials and products, resulting from successful research work, did much to meet increasing competition both at home and overseas. Several products of this division had been adapted to specialised uses such as oil-resisting hose and acid-resisting linings for tanks and other containers..

Of the many new products developed in 1954, Fortiflex containers made of rubber-resin material which was flexible, durable, and non-corrosive, had proved highly suitable for industrial purposes.

Semtex Ltd. had again had a successful year with record sales during 1954. Development work into new types of flooring materials was continuing and plans were in hand for extending the range of such materials. To meet the increasing demands on the company, production was being considerably expanded and augmented by the production facilities in South Wales acquired by Dunlop last year.

Considerable Technical Progress

Considerable technical progress had been achieved by the company in the polyester resin/glass field and, while small-scale production had already commenced, plans were in hand for development, particularly to meet the demand for specialised products.

Dunlop Special Products had maintained its prominent position as a supplier of adhesives and solutions to the car industry and sales increased by over a third compared with 1953. The polyvinyl acetate emulsion marketed under the trade name 'Polimul' was now well established in the paint trade and had a growing number of other applications.

Instrumental Particle Size Analysis

by J. R. MAJER, Ph.D., D.I.C., A.R.I.C.

MORE and more of the manual operations carried out previously by the analytical chemist have been replaced in recent years, or have become capable of replacement by simpler, more rapid, and it is to be admitted, often more expensive instrumental procedures. This has come about in two ways; by the discovery of new, totally different routes giving the measurement of the required property, and by the development of an instrument capable of simulating the manual operation automatically and hence more rapidly, tirelessly and with a predictable error.

The most recent operation to suffer this latter fate is that of particle sizing and counting, and this has come about because of the great increase in interest manifested in this field both by industry and public authorities. For some time the analytical control of particle size in powdered products has been important in the paint, powder metallurgy, pharmaceutical, cement and powdered fuel industries. The quality of the products manufactured by these industries is determined in many cases by the particle size distribution of the powder, because this factor may control a number of important properties such as the chemical reactivity, the colour, or the rate of absorption.

Setting Time & Strength

As an example, the setting time and the tensile strength of cement are both affected by the fineness of the grinding process. The finer powders set more rapidly and have a greater tensile strength, but there is a greater rate of heat evolution which can lead to cracking and distortion. There is a compromise to be struck between these conflicting factors, the economic considerations of milling costs and the question of end-use. A more striking example, although on a smaller commercial scale, is the use of certain powdered metals such as zirconium and tantalum for removing traces of gases from thermionic valves. Preparations of these powders in liquid suspension, known as 'getters' are applied to the anode of the valve as a spray. To facilitate spraying and to promote adhesion to the anode it is found that the particle size must be kept within well-defined and restricted limits. Furthermore, within these limits the distribution must be constant, excess of large particles leading to poor adhesion, and excess of small particles creating difficulties in the control of the spraying process.

Most recently, prompted by research upon air pollution and the intensive study of mine atmospheres sponsored by the National Coal Board, a great deal of attention has been paid to the particle size of airborne dusts. The necessity for knowing the particle size distribution of such dusts derives not only from the fact that the susceptibility to removal by filtration or precipitation is determined largely by size considerations, but also from the differing physiological action of different size ranges.

Inhalation of Dust

When dust-laden air is inhaled the larger particles above 10 μ in diameter are deposited upon the ciliated epithilium of the respiratory tract and are carried upwards upon a film of mucus to the mouth. Smaller particles of about 2 μ in diameter penetrate further into the lung and are deposited by gravitational sedimentation upon the alveoli. Very fine particles below the limit of resolution of the optical microscope are deposited by Brownian motion, and in between these two size ranges neither mechanism is particularly effective, the minimum being reached at 0.3 μ. The physiological symptoms which are evoked by dust inhalation depend upon the chemical nature of the dust, but the site of attack is dependent upon the size.

There are two fundamentally different approaches to the determination of particle size distribution; the first depends upon measuring some gross effect produced by a large number of particles and may involve sedimentation in a fluid or measurement of the opacity of a suspension. The second approach involves the individual examination of the particles, a representative number of which are counted and sized.

In general the former is a more rapid and more precise, but less accurate method, while the latter when not automatic is tedious and not very precise owing to the diffi-

culty of securing a representative sample for examination, but can give a very accurate and continuous picture of the particle size distribution. When the powder does not contain substantial amounts of material below 50 μ in diameter it may be examined with the aid of a range of standard sieves. Below this limit one of the two alternative routes must be used.

Sedimentation Process

The process of sedimentation is that most frequently used as a basis for particle size analysis of materials in the subsieve size range when appreciable quantities are available. In this method, particles are classified by the rate at which they descend through a vertical column of liquid under the influence of gravity. The operation begins with a uniform dispersion of the powder in the liquid and after a time a density gradient is established in the liquid. Some means of measuring this gradient is used in order to find the size distribution.

The most straighforward method is to withdraw by means of a pipette, small samples of the suspension at known times and at a fixed point below the surface. Then the largest particle in each sample will be that which has fallen from the surface of the liquid to the jet of the pipette. This size can be calculated from Stoke's Law and the amount of solid material in the sample determined by filtration or evaporation followed by weighing of the residue. This weight, expressed as a percentage of the whole, corresponds to the percentage undersize. By withdrawing samples continuously a curve of percentage undersize may be constructed and the size frequency calculated.

This rather tedious procedure can be obviated by the direct weighing of the material as it settles. The difficulties of achieving this with the conventional balance without disturbing the sedimentation by pan oscillations are obvious, but they have been overcome in the model produced by A. Gallenkamp & Co. Ltd. which uses a torsion balance. The particles settle upon the pan which is suspended in clear liquid to avoid the effect of density changes in the suspension. The instrument is said to be sufficiently sensitive to permit the examination of very dilute suspensions of particles in the size ranges of 2-20 μ and 5-75 μ.

Manometric methods which have been suggested as a means of measuring the variation in density of the suspension suffer from the disadvantages of sluggish response to density change and the necessity of measuring to a high degree of accuracy very small differences in liquid level.

One of the most accurate methods of size analysis by sedimentation is to photograph the suspension with a lengthy exposure under brilliant dark ground illumination. Each descending particle then produces a track upon the negative, the length of which is proportional to the terminal velocity and hence to the diameter of the particle. The disadvantage is that at least 1,000 tracks must be measured in order to ensure accuracy. The chief source of error as with all methods involving visual individual inspection is due to the difficulty of selecting representative samples of the total population.

This disadvantage is not shared by the photo-extinction method in which the light transmitted by a settling suspension is continuously recorded photoelectrically. The particle size distributed can be calculated from the resulting curve and this is claimed to be the best of the sedimentation methods.

It is, however, in the field of the counting and sizing of individual particles that the most recent advances have been made, and it is relevant to consider how this is carried out visually. If the material to be analysed is in the form of a powder a satisfactory sample must first be spread on a microscope slide in such a manner that no undue aggregation occurs and all size ranges occurring in the original material are represented. It is customary to disperse the powder in a suitable fluid which can be evaporated if necessary, difficult powders have been dealt with by electrostatic dispersion or by mechanical separation in a viscous medium.

Thermal Precipitation

There appears to be little hope that this particular procedure, which succeeds only after trial and error, will be made automatic. If the material to be examined is in the form of an airborne dust it must be collected on a microscope slide by means of a thermal precipitator which makes use of an electrically heated wire to repel the dust particles and deposit them.

However prepared, the slide is finally placed on the mechanical stage of a microscope and examined, using an objective suitable for the size range under study. The

size limit of visibility varies greatly with the nature of the material, the manner in which it is mounted, the objective used and the method of illumination. In general, particles are seen best with dark ground illumination, but this is often more tiring to work with.

Under favourable conditions, particles down to 0.2 μ in diameter can be seen, but for practical purposes the smallest particle which can be measured to any degree of accuracy has a diameter of at least 0.5 μ. It is commonly found that more particles appear in a photograph of a given field than can be counted visually. Very fine particles must be dealt with by the use of the electron microscope.

When counting and sizing, the individual particles are compared with a standard graticule, which may be situated either in the eyepiece of the microscope, or upon the screen if a projection instrument is being used. The graticule serves both to define the area within which particles are counted so that the number concentration can be worked out, and to provide a series of circles of known diameter with which the particles can be compared. The size of these circles varies with the magnification being used and the graticule must first be calibrated by comparing it with a standard scale etched upon a microscope slide.

There are four types of graticule, all quite similar, which have been used. The first, which is also the original, is the Patterson-Cawood design which consists of a rectangular subdivided area, a range of ten opaque spots above and ten circles below. This type has the disadvantage of providing too restricted a size range so that it is best suited for the accurate determination of the size range of fairly uniform powders. Furthermore, the diameters of the circles are not in any fixed ratio so that difficulties arise when the magnification is changed during a count.

Reference Circles Tiring

Graticules containing a large number of reference circles are tiring to work with because of the difficulty of deciding which of two circles nearly equal in size the irregular particle most nearly approaches in size. The Watson graticule has 'lead-in' lines which attract the eye to particles approaching the counting area and provides a range of only three reference circles whose diameters correspond to particle sizes of 0.5, 2 and 5 μ which are the physiologically significant sizes. The graticule which has been adopted by the National Coal Board after investigation incorporates the rectangular grid and lead-in lines but has four reference circles corresponding to 0.5, 1, 2.5 and 5μ.

Using the NCB Graticules

In sizing particles with these graticules it is customary to imagine the profile of each particle to be transformed into a circle of equal area and then to judge which of the reference circles this size falls between. It is important to recall this convention when considering the operation of automatic sizers, since it is a process which is not easily simulated instrumentally. When counting or sizing the operator sets one edge of the graticule at right angles to the direction of traverse of the mechanical stage and then steadily traverses the slide across the field. Each particle is dealt with as it passes one edge of the grid, provided that it moves between two lines parallel to the direction of traverse. The area covered is governed solely by the extent of traverse possible or desirable from the quality of the deposit. Edge-errors are avoided by the convention of counting those particles which touch one edge only and ignoring those touching the other.

It is common to find that in a deposit the number of fine particles is far in excess of that of the medium sized particles, while there are almost always very few coarse particles. Thus, if a count of only 1,000 particles is made the number in each group varies widely and since the statistical error involved in estimating the particle size distribution of the total population from a limited count varies inversely as the square root of the number counted, the proportion of finer particles is known with greater accuracy than the others. This can be avoided by counting the smaller particles with a higher magnification, allowing two or three sizes to overlap so that a single distribution may be synthesised.

It can be seen that the accuracy of the sizing must be affected by various psychological factors, the field often containing shapes capable of inducing optical illusion; the size of any particular particle for instance, may appear to depend upon its immediate environment. Temperament and

fatigue are factors which also have considerable effects.

Recently a programme of investigation was initiated by the National Coal Board in which the performance of a number of operators in several different laboratories was checked. In the first set of comparisons made between the results presented from a series of standard thermal precipitator slides, large differences appeared. These differences were reduced gradually as the number of checks increased, particularly in those results presented by workers in a single organisation. No reasonable explanation could be offered for this phenomenon other than that a more rigid discipline resulted from the knowledge of cross-checking.

Adequate Training Necessary

The necessity for adequate training and precise instructions for operators was evident, but one of the supposed sources of error was proved to be of secondary importance. This was the vexed question of the counting of aggregates; i.e. whether the individual particles where distinguishable, should be dealt with separately or the aggregate treated as a single large particle.

From the physiological point of view aggregates or flocks of airborne dust should be considered as single particles since they are inhaled as such and behave as such in the passages of the lungs. In other powders which may form aggregates due to magnetic or electrostatic forces it is better, when complete dispersion is impossible, to estimate the number and size of the separate particles.

More information about the behaviour of individual operators has been obtained by the use of an artificially prepared slide. This test strip contains 200 irregularly shaped profiles within the size ratio of 4.5:1 and has been used to assess personal bias and to reject those individuals, who for reasons of temperament will never become accurate and reliable operators.

From this brief exposition of the technique of particle size analysis it can be seen that there is a great need for an instrument capable of counting and sizing accurately at high speed. It can also be seen that some compromises must be made with accepted practice in the design of any such instrument because of the impossibility of incorporating the ability to make decisions concerning the validity of shapes in the field of view. All methods so far have depended upon detecting the change in light falling upon a photocell caused by the intervention of a particle and the various instruments have resulted from different methods of adapting this same principle to the imitation of visual counting. This process may be summarised as (1) location of the particle in the random field, (2) counting it, and (3) classifying it.

The problem of location can be simplified if the distribution of the particles can be changed from a random to an ordered state and this has been achieved in certain specialised cases when the particles are suspended in air or in a liquid. One such device used for the examination of airborne dusts allows a very thin stream of dusty air to be passed through a beam of light in such a manner that only one particle at a time is illuminated. The particle, under dark ground illumination scatters light to a photomultiplier tube which estimates the size from the intensity of radiation. A sheath of clean air surrounds the dust stream, confining it to a well defined zone and preventing deposition on the surrounding walls. The lower limit of counting is said to be 0.34 μ.

A similar principle is involved in an instrument designed to count the number of red cells in human blood samples. This is a simplified problem because the necessity for sizing is eliminated. In the model developed by Evans Electroselenium Ltd. the sample of diluted blood passes through a capillary to the counting chamber where the cells are accelerated by a stream of distilled water passing to a fine jet. The acceleration spaces out the cells as they approach the jet where they are illuminated and scatter light to a photocell. The signal produced is amplified and passes an amplitude discriminator to eliminate spurious counts before operating a five-stage counter. The usual speed of counting is about 200/sec. but the equipment is capable of working at one hundred times this rate in order to deal with inadequate cell spacing.

More Generally Useful

The more generally useful instruments are, however, those which are capable of dealing with a random distribution of particles upon a microscope slide or their images upon a photographic film. One method is to scan the field with a spot of light comparable in size with the smallest particle it is desired to record. This in effect draws a line across

the field and the transmitted light intensity falls sharply when a particle is intercepted. The photocell detecting the transmitted light then produces signals of the 'on-off' type in which the duration is related to the intercept of the particle on the line of scan.

The number of signals and their duration can be recorded, but the number in a given length of scan does not correspond to the number of particles within the scanned area because, in a heterogeneous field, the larger particles will intercept the light more often than their smaller neighbours. It also follows that because of these multiple intercepts the duration of a particular signal does not necessarily correspond to a diameter of a particle. If, however, a number of scans are made across the field each particle will give rise to a characteristic group of signals and provided that the particle shape is known these signals can sometimes be analysed into groups corresponding to individual particles. Since all scans across a random field are statistically equivalent it is immaterial whether the scans are regularly or irregularly spaced.

This method has been used successfully in the study of agricultural sprays to count and size the stains which spray droplets produce upon white paper when a black dye is incorporated in the spray. Because all droplets produce circular stains the problem of relating signals to stains is comparatively simple. When however profiles other than circular are examined there appears to be no simple relation between intercepts or signal durations and the profiles producing them even when these are regular figures. When, as is most common, the particles are irregular and heretogeneous, conditions are most unfavourable for this method.

Overlapping Possible

If the field is scanned by a narrow slit moving at right angles to its length, rather than a spot, then a path of definite width is covered and signals from a photocell placed below the illuminated slit indicate when it is totally or partially obscured by particles. As the slit length is large with respect to the smaller particles being counted, several may intercept the slit at one time while there is also the possibility that larger particles may overlap the extreme ends of the slit.

These two possibilities are linked in a statistical manner with the length of the slit, a long slit reduces the fractional edge intercept contribution but increases the possibility of multiple interception. In a statistical analysis of slit scanning it has been shown that for a given density of deposit a slit length can be chosen which minimises both these sources of error and also to some extent the error due to aggregation.

More Satisfactory Method

A more satisfactory method of eliminating the error due to fractional intercepts is illustrated in an apparatus used for the counting of red cells. Here the field is scanned with slits of two different length, l_1 and l_2. The signals then correspond to scans of length $l_1 + d$ and $l_2 + d^2$ where d is the diameter of a red cell. By subtracting the two counts the edge error is eliminated and a count is obtained which corresponds to a scan with a slit length of $l_1 + l_2$. This, however, takes no account of multiple intercepts and a statistical correction has to be applied to the final count.

An interesting extension is the possibility of making the second slit so narrow that it becomes in effect a spot; the principle still remaining valid. The disadvantage of a difference method such as this is that the statistical errors of both counts are additive so that a much larger number of particles must be counted to give the same accuracy as a single straight count.

When a random field of particles is being counted visually with the aid of a graticule the question of edge errors is dealt with by counting those particles which give fractional intercepts on two of the four edges only, or if the field is being traversed, those intercepting the upper edge only. Attempts have been made to avoid edge errors by imitating this practice instrumentally and using an illuminated 'guard spot' at the base of the slit. Two photocells are employed one detecting light intensity changes from the slit and the second those from the spot. All significant changes in light passing the slit are recorded except in the case where there is a simultaneous signal from the spot indicating fractional interception at that end of the slit. As in the previous systems no provision is made to take account of multiple interception.

The slit and guard spot have been replaced by two spots separated at a distance longer than the spot diameter and the limit of resolution. All particles whose lower edges lie between the track traced by the

spots are counted. A further refinement is to use a single spot and scan in single lines recording each line so that it is available for comparison while the next adjacent line is being traced. This avoids the difficulty which occurs when the scan and guard spots are made very close together so as to avoid missing small particles with a resulting loss of accuracy in the measurement of spot separation. There are several methods of achieving line comparison; the signals may be recorded or an electronic delay line or 'memory' inserted in the photocell circuitry.

The account so far has been limited to the problems of automatic counting. This is sufficient for some purposes such as the examination of blood samples, but for control of chemical products or for the study of airborne dusts in mines and factories some form of size analysis is essential.

If single slit scanning is used then the amplitude of the signal recorded when a particle crosses the slit gives an indication of the particle diameter, provided that multiple interception has not taken place and the edge error has been eliminated. Sizing can be achieved by varying the 'sensitivity' of the slit, i.e., the amount of the slit which must be obscured in order to produce a count.

If the slit of length l requires a fraction z to be obscured before a count can be recorded, then all particles of diameter greater than z will be recorded in the track having a width of $l + d - 2z$ where d is the average oversize diameter. If now as before the field is scanned with two slits of lengths l_1 and l_2 (both greater than z) the difference in the two counts will correspond to all particles larger than z in the track of width $l_1 - l_2$. By varying z an oversize curve may be plotted and the distribution calculated. When z equals 0 all signals are recorded, i.e. the instrument counts without sizing.

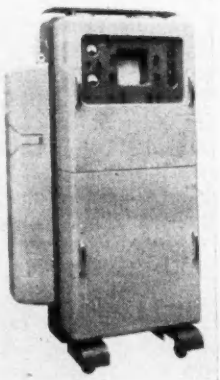
An alternative method is to make a pair of scans with two slit lengths and classify the signals into amplitude ranges electronically. A further method is to vary the length of the slit and count only complete obscurations, eliminating edge errors by using a guard spot situated at a distance x from the slit end. Then all particles are counted whose edges pass in the track of width x and whose diameter is greater than l. The oversize curve is built up by taking a number of values of l.

The guard spot technique may be extended by arresting the scan when the edge of the particle has been uniquely located and allowing one spot to explore the particle measuring either its diameter or its perimeter.

Two Theoretical Possibilities

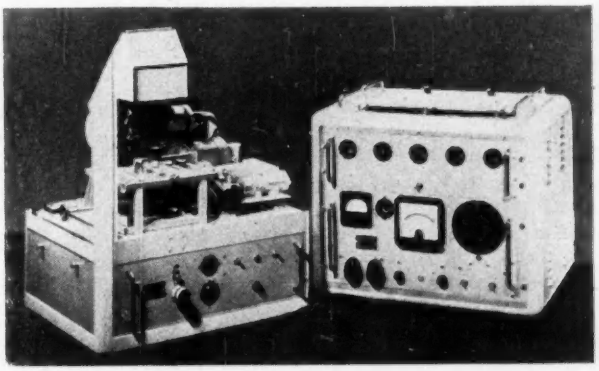
In all these methods the field is traversed by a beam of light, and from the theoretical point of view it is immaterial whether the particles are moved through the beam of light, or the beam of light crosses the field. If it is the slide which is moved then the optical system remains undisturbed, and the light intensity is less likely to vary and cause spurious signals; on the other hand the speed of traverse and the rate of reciprocation of the slide are limited by mechanical considerations, and there is also a limit to the accuracy with which the movement can be confined to the plane of focus.

Mechanical scanning is, therefore, most suitable for systems using a slit which do not require such a high frequency of scan and which may require quantitative measurement of transmitted light. When high speed scanning is required it is best to move the light beam and this can be achieved by employing the principle of the 'flying spot microscope' in which the scanning spot is produced by a cathode-ray tube assembly and a greatly reduced image of its face focused upon the slide. Although there are small inherent brightness variations in the spot due to differences in the surface of the cathode-ray tube and the angle of incidence of the light, no quantitative measurement of the signals is required for spot scanning, and this method can be used successfully.



The film scanning portable analyser developed by Mullard Research Laboratories

The Cassella Electro-mechanical Particle Counter



Two instruments illustrating these two different scanning techniques will now be described. They are both in an advanced state of development and were shown this year at The Physical Society's Exhibition of Scientific Instruments.

The first is the Film Scanning Particle Analyser, an experimental model developed by Mullard Research Laboratories. It employs scanning with a moving spot of light, and although it is capable of adaptation to be used with specimens on microscope slides, it has been designed primarily for the examination of intermediate records on 35 mm. photographic film. This permits a wider range of application and allows the instrument to deal with sub-microscopic particles by the examination of electron micrographs.

The photograph of the field of particles is scanned by a flying spot system which is focused by means of a reducing optical system on the film and the light transmitted by the photograph is detected by a photomultiplier tube. Signals are provided which are related to the density of the silver image so that it is essential for the record which may be either a positive or a negative to have reasonable contrast. Whenever the scanning spot encounters a particle image upon the film the resulting signal from the photomultiplier is compared with that obtained in a similar position on the previous adjacent line of scan.

If the image has not intercepted this line then it is being encountered for the first time and a count pulse is fed to the recording section. If, however, the previous scan was intercepted, the pulse is suppressed and no further count is made. This eliminates the fractional interceptions or edge errors discussed previously.

The method used to provide the comparison is to incorporate a magnetostrictive delay line having a transmission time equal to the scanning time of one line. A rapid secondary exploring scan is employed to size each particle without interrupting the counting scan. The exploring scan is initiated by the count pulse at the end of the first image intercept. The scanning spot then moves in a direction downward and backward from the direction of scan across the image until it emerges when it rapidly returns to its normal position. The length of the excursion so produced is taken as a measure of the image size.

It can be seen that although this convention is as valid as that employed in visual sizing it is different in nature. When sizing, a calibrated measuring system allows a count to be made only for those images producing excursions greater than the selected size. The field of 25 mm. × 25 mm. is covered by a scan of one hundred lines in 1/10sec. and there is a cathode ray tube display which indicates the particles being counted by means of bright marker tags.

The diameter of the smallest image which can be counted is 0.25mm. (one hundred thousandth of the total field area) and these images must be separated by at least one diameter in order to be resolved by the instrument. The maximum excursion of the secondary scan is 5mm. so that the size range covered is 20:1.

The apparatus for particle sizing and counting developed by Cassella (Electronics) Ltd., uses slit scanning with a fixed optical system and a moving slide. Movement is achieved by mounting the specimen upon a reciprocating stage which is supported on flat parallel springs and can be pulsated rapidly while remaining flat. The scan con-

sists of two hundred traverses of 10mm. each in the form of a *sine* wave, counting being suppressed as the stage changes direction at the end of each traverse. The scan is complete in a time of less than a minute.

The optical system consists of a conventional microscope, a number of accurately made slits and a set of neutral filters to match the opacity of the specimen. The transmitted light is detected by a photocell, the output of which is submitted to a pulse amplitude discriminator when sizing. The setting of this device is related directly to the sensitivity of the slit or the fraction which must be obscured before counting occurs. At present this instrument has a maximum resolution of $4/5\mu$.

The most serious difficulty encountered in the development of automatic particle size analysis has been the small amount of light which is available at the detector. If, for example, a particle of diameter 1μ is to be counted and sized then the illumination must come from an area not much greater than $1\mu^2$ whichever method of scan is adopted. No more light can be concentrated upon the image plane than is emitted per unit area at the source, so that even with small sources the intensity may be reduced by a factor of a million. This means that photomultiplier tubes rather than photocells must be used for detection, and the performance of most instruments is limited by the signal to noise ratio in the photomultiplier circuits which can only be increased by increasing illumination.

Several Disadvantages

For this and other reasons it seems probable that the resolution of automatic particle sizers using visible light will be inferior to that which can be obtained with a trained operator and a good microscope. The high magnification for example requires the use of objectives of large numerical aperture which must have a very small depth of focus of the order of 1μ. This makes it difficult to maintain accurate focus while scanning.

The visual operator continually reasons as he examines the field, changing the focus to distinguish between particles and defects in the optical system, to compensate for the uneven nature of the deposit and to correct for curvature of the microscope field. These are processes which it would be difficult to incorporate in a machine, and resolution must be sacrificed to gain depth of focus. Thus, a resolution of 1μ and below is likely to be inaccessible to the automatic sizer working upon a deposited specimen.

If, however, an intermediate photograph is made then the problem is simplified to some extent for the designer of the instrument who can control the contrast and brightness of the field and use a much lower powered objective. The problem is, however, merely passed on to the photomicrographer whose records must have the same very high resolution which is by no means an easy task to achieve. Recourse must be made to photographic materials having very fine grain and good contrast, and it is possible that improvement in definition might be achieved by the use of ultra-violet light. Whether the accuracy (1 per cent) and speed of the automatic sizer is offset by the necessity for this preliminary work is a debatable matter. There can be no question of its value in the study of electron micrographs.

Glassware Catalogue

COINCIDING as it does with the British Instrument Industries Exhibition, the catalogue 'Interchangeable Laboratory Glassware' published by Loughborough Glass Co. Ltd., Loughborough, Leics, is of particular interest. The products available include condensers of all types, adapters, Soxhlet extractors and filter funnels. Micro-distillation apparatus is also manufactured in sizes ranging from 10 to 100 ml.

The company have also produced a leaflet describing their industrial glass condensers. These are claimed to have greater efficiency, mechanical strength and flexibility than more conventional designs.

Petroleum Equipment

A REMARKABLY comprehensive range of equipment is listed in 'British Petroleum Equipment' 1955/56 edition, published by the Council of British Manufacturers of Petroleum Equipment.

In the space of about 760 pages is contained information on the manufacturers and suppliers of every type of equipment used in the petroleum industry.

The book is published by CBMPE at 79 Buckingham Palace Road, London, S.W.1, price 50s. CBMPE will also supply information on equipment which is not specifically listed in the volume, but which can nevertheless be obtained in Britain.

'Enforced Order' Mixer & New Adjustable Extruder†

*by DR. M. S. FRENKEL**

THIS article introduces a new continuous mixer for materials in powder or other states, which is distinguished from other mixers in producing homogeneity, and uniformity of other properties to any required degree, instead of producing a mix representing an average of widely differing extreme qualities of which the worst qualities are determining for the overall properties. This result can be achieved with controlled (minimum) heat input, by control of velocities of components independently of one another.

Uniform Heat Output

This new mixer is shown in application to a new extruder type, in which it is incorporated not only for compounding but also for producing uniform heat input by mechanical work, with application of a new principle of control. Instead of having rotational velocity and change of rotational velocity invariable along the extruder axis, the rotational speed and its changes are adjustable as functions of position along the axis.

This enables one to produce along the axis of the extruder the required changes of state mixing, density, temperature, pressure, etc., suited to the properties of the material and to the required extrusion conditions, without altering the geometrical configuration of the apparatus, by adjusting independently of one another the angular velocities of certain components along the axis.

This makes the extruder widely applicable for different materials and applications, and also permits its use for research to determine best adjustments for any material and performance. It combines compounding, etc., in one machine, dispensing with separate Banbury mixing and homogenising, with all its disadvantages of open-to-atmosphere batch operation, and provides adiabatic uniform controlled heat input, instead of conventional heat transfer from elements, thus doing away with lack of uniformity in heating, limitations on throughput, on speed of operation, and other drawbacks.

A multi-mixer using both principles is indicated, to carry out two or more mixing operations, with or without chemical reaction, simultaneously, though each under its own controlled conditions as to processing times, etc., and which then compounds the results of these operations without time intervals for oxidation, demixing, etc., to occur. This, as well as the simple mixer, can be used for research into processing conditions.

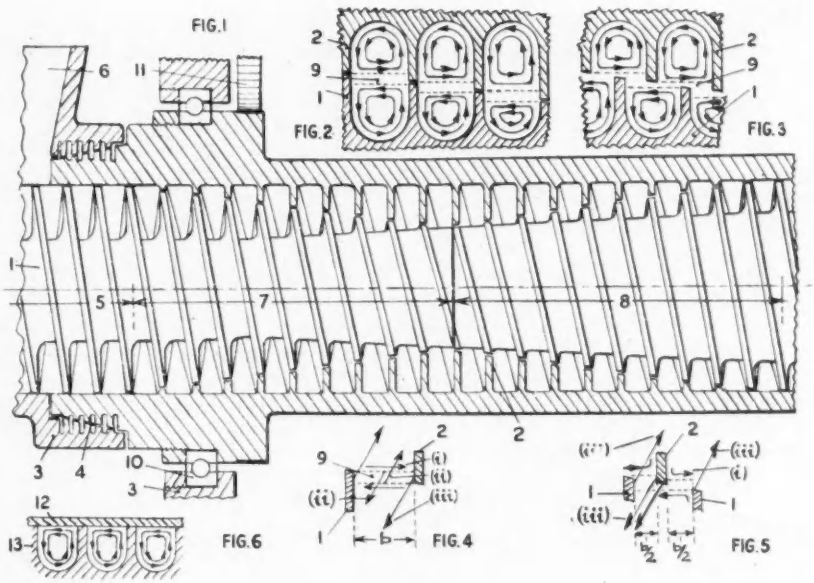
A dynamic gland utilising the new principle is also shown.

The new mixing apparatus (Fig. 1) comprises an inner screw (1) and an outer screw (2), both rotatably mounted in the casing (3), with the gland (4), which may be of the new dynamic type (Fig. 10), sealing the joint between the outer screw and the casing. Screws (2) and (3) have oppositely directed threads and are here rotated in opposition, with independently adjustable velocities. Leading from the entry funnel (6), the screw (1) comprises a feed section (5) in which the threads extend to the wall of the casing (3), and following this the mixing section (7) (8), where in (7) the cross-sectional area of the groove is gradually reduced from its initial value to zero and in (8) this groove cross-section increases again from zero to a maximum value.

---

†*Covered by patent applications*

**Editor's Note:—Dr. Frenkel is a consulting and research physicist, mathematician and engineer. He has published a number of papers: on nuclear physics (Z. f. Physik), on engineering researches, e.g. on control-mechanisms, etc. (Proc. I. Mech. E.), on ball bearings (J.R.Ae.S.), etc. While in charge of research for an engineering firm during the war and in later consulting practice, he has provided by his mathematical methods, without previous experience, solutions of fundamental engineering problems which were subsequently confirmed by experiment on his own designs.*



Correspondingly, the groove cross-section of the outer screw increases in (7) from zero to a maximum and in (8) decreases from this maximum to zero. These changes of groove cross-section are here effected by the indicated variation of the land radii of the inner and outer screw together with complementary variations of the depths of grooves from full depth to zero and *vice versa*, although, in general, these changes could also be brought about by corresponding changes of groove depths and/or pitches of the screws, even with constant land radii. The characteristics and shapes of each screw can be suited to the particular application.

In operation with the screws rotating in opposite directions, this construction provides in section (7) a transfer of material from the inner screw to the outer screw until the inner screw is empty at the end cross-section of section (7) and in section (8) the return transfer from the outer screw to the inner, with the roles of giver and taker reversed, until at the end cross-section of (8) the outer screw is empty again. At the same time, as seen in Figs. 2 and 3, a zone (9) of intermixing (in three mutually normal planes, as treated presently) is provided between opposite grooves where, considering one groove in the inner screw from the beginning of section (7) to the end of section (8) in which its depth varies from full to zero and back to full again, this zone moves from top to bottom of the groove and back again to the top. Since this occurs all round the screw, the whole of the material to be mixed is covered twice in the mixing cycle in section (7-8), providing the 'enforced order' mixing more fully treated hereafter.

In the material transfer in section (7) the inner groove continuously recedes from a thin layer (9) of material which is taken up by the outer groove while subjected to intensive mixing as follows: In the cross-sections of the grooves (see Figs. 2 and 3) vortices arise due to the various effects therein, e.g. (**1**) (Fig. 1), as can be proved, these vortices in opposite grooves increasing and decreasing in material content with the changing groove cross-sections. [Compare this to the vortices (Fig. 6) in a conventional screw rotating in a cylindrical barrel, e.g., extruder, in which the same material rotates in the same groove in stratified formation, see ref. (**2**) (Fig. 5)].

Accordingly, each thin layer (9) has on either side material moving with opposite velocities in the axial direction (Figs. 2 & 3) providing a couple (arrows (i) on Figs. 4 & 5) producing 'shear mixing' of such layers (9) in all planes containing the screw axis all round the circumference. This is,

however, only one of the three mutually normal planes of 'shear mixing' for each intermixing zone (9), there being altogether:

(i) shear mixing in all planes containing the screw axis all round the circumference (see arrows (i), Figs. 4 & 5);

(ii) shear mixing in circumferential directions in planes normal to the screw axis, because each element (9) is transferred from the inner screw rotating in one direction to the outer screw rotating in the opposite direction (see arrows (ii), Fig. 4);

(iii) each layer (9) is at one side in contact with a land from the inner screw (1) rotating one way and at the other side with a land from the outer screw (2) rotating the opposite way (see Fig. 4) so that a couple is exerted on the element rotating this about axes normal to and intersecting the screw axis at all circumferential positions (see arrows (iii), Fig. 4).

However, the 'shear mixing' rotation according to (iii) does not only arise for elements of the width b of a groove, but for elements from this width down to zero width, because in the relative motion of the grooves (see Fig. 2 & 3) each land covers the entire width of the opposite groove, giving rise to ever-different couples due to forces from the lands. This is shown in Figs. 2 and 3, showing two configurations of opposite grooves in the plane of section of Fig. 1 before and after relative rotation of the screws through an angle $\pi/4$, and on Figs 4 & 5, showing corresponding details of the mixing zones (9). Fig. 5 shows the reduction of arm of couples (iii) from b to $b/2$ and also the slicing of the mixing zone (9) by the top of the land moving across the groove. Lack of space prevents going further into representation of this 'shear mixing', with the most important aspects of complete mixing, in connection with opposed rotations, and proofs relating thereto.

Occur Successively

So far the intermixing occurrences for one cross-sectional plane of the grooves have been considered. However, when one considers one helical groove in the inner screw (the 'giver' in section 7) which starts from maximum depth at entry and reduces to zero depth, these intermixing processes are seen to occur successively in a continuous series of zones (9) moving from the top of the groove at entry right down to zero depth. In section (8), where the outer screw is the 'giver', the continuous series of mixing zones (9) moves from zero depth back to the top (full depth) of the groove in the inner screw, and as such intermixing proceeds all round the circumference, all the material to be intermixed is treated twice in one cycle of this 'enforced order' mixing, with 'shear mixing' in three mutually normal planes.

Differentials Integrated

Considered in a different way, at the end of section (7) the outer screw-groove as 'taker' of material has integrated all the differentials of material which have been provided successively for intermixing by the inner screw-groove (as 'giver') in its change from full depth to zero depth. In section (8) then, the outer screw-groove, which integrated in section (7), now successively provides the series of differentials which are mixed and successively integrated in the inner screw groove now acting as 'taker', which shows 'enforced order' mixing from this standpoint. The 'enforced order' mixing proceeds with an interchange of position of 'giver' and 'taker' in the complete cycle of material transfer which can be shown to be analogous to the action of an electrical condenser with corresponding occurences in three mutually normal planes.

In one such cycle as shown with reference to Fig. 1, all particles undergo substantially the same amount of mixing. However, for various requirements, mixers can be made which comprise two or more such cycles (see Figs. 7 and 9)—particularly in view of the fact that by adjusting the angular velocities of rotation of the inner and outer screw to suitable low values undesired heat input during mixing can be kept very low (see also final paragraph).

The new 'enforced order' mixers prevent the occurrence, as in conventional mixers, of a mix representing an average of widely different extremes of quality, in which the worst qualities are determining for the overall quality of the mix. Such effects are, for example, the outcome of the use of indiscriminate turbulence, which produces, in the instance of heat transfer, useless intermixing of hot particles with hot particles, useless intermixing of cold particles with cold particles, and only as a partial effect the required intermixing of hot with cold particles.

In applications where the homogeneity of mixing of component materials is determin-

ing for strength of a resultant material, this performance of conventional mixers results in spots of maximum strength and spots of minimum strength, where however it is not the spots of maximum strength, but the weak spots which determine the overall strength.

Apart from that, the motions involved in conventional mixing operations themselves have a component effect of demixing, on account of dynamic forces (e.g. centrifugal force) acting on differences in density, in particle-size, etc. Furthermore, batch-operation is inherently uneven from batch to batch.

Fig. 7 shows diagrammatically the new extruder embodying two cycles (each denoted I-II) of the above mixer, following the feed section (21) of the inner screw (20) and leading up to the metering section (30). According to the new principle of control, the adjustability is provided by making the outer screw in four sections (22), (23), (24), (25), corresponding to sections of the mixing cycle, and making these sections independently rotatable, with their angular velocities independently adjustable by gearing-means (26), (27), (28), (29). Further adjustability is provided by making the inner screw (20) also of at least two sections which are independently rotatable with independently adjustable speeds by the provision indicated in Fig. 8. Glands (4) seal the joints between independently rotatable sections, as treated later. The extruder indicated has a maximum number of adjustable components, as required for research purposes. Production extruders require fewer independently adjustable components, e.g. a one-piece inner screw and/or fewer independently rotatable outer sections (see also final paragraph).

This new construction enables one to produce along the extruder, as function of the axial position, the required states and changes of state of intermixing, density, temperature, pressure, etc., suited to the properties of the plastic and the required extrusion conditions, only by adjusting the angular velocities of the indicated components independently of one another.

In conventional extruders, the angular velocity and change of angular velocity of the screw are not functions of axial position, but are the same all along the length. From the viewpoint of controlled performance along its length, and particularly adiabatic performance, then, although the overall screw-speed can be adjusted, any value of this is good only for one axial position and effect produced there, and bad for any other axial position and effect. The only other way out, alteration of the geometrical configuration of the screw as function of axial position, is not feasible.

The design of screws of specific configuration is no solution from this viewpoint of controlled, particularly adiabatic, operation because:

(i) The properties and changes of properties of plastics along a screw required as basis for design are largely unknown;

(ii) At best, a required set of end-conditions within a narrow range can be obtained for only one rate of throughput (ref. 3), which is completely insufficient in view of the wide variation of requirements and ex-

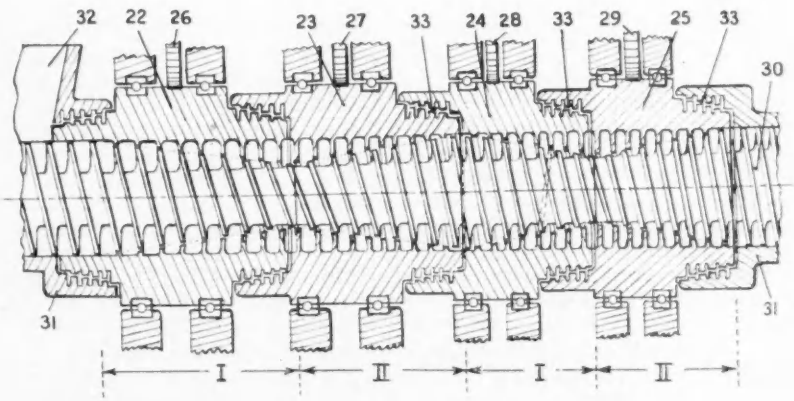


FIG. 7

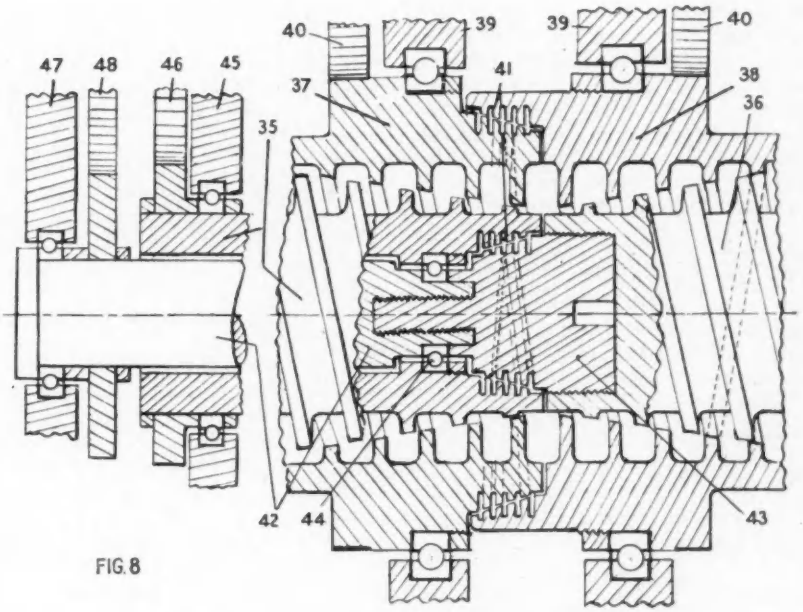


FIG. 8

ternal conditions occurring in practice;

(iii) The influence of even engineering tolerances prevents uniform operation;

(iv) Such a specific design is inapplicable for different plastics and even for the same plastic under various requirements.

All these drawbacks are overcome, and the recognised great advantages of adiabatic operation (see refs. **2** and **4**) achieved, by utilising the only variable which is adjustable as function of the axial position, viz., the rotational velocity, as in the present construction:

(i) In this construction, instead of being compelled as in conventional types, to provide heat input by way of external heaters at some axial positions, and to provide cooling at other axial positions, both of which are bound up with harmful temperature gradients (uneven heat distribution, etc.)—one is enabled to obtain the required effect suited to the properties of the plastic and the required end conditions, at any axial position by independent adjustment of angular velocities of components. This applies equally to mixing, changes of density, pressure—e.g. saving the excessive pressures now used in attempts to produce mixing at the end of the screw, etc.

(ii) The new construction enables compounding, homogenising and extrusion to be combined in one machine, providing complete uniformity of product, free from weak spots which determine the overall strength of the product.

(iii) The machine can provide any set of extrusion conditions, and for each of these any required rate of throughput, transcending the limitations of conventional types.

(iv) The same adjustable machine applies to different plastics.

(v) The same machine can be applied to research purposes, to determine the different angular velocities required along the axis for both inner and outer screw for any plastic or process, enabling production extruders to be built accordingly with fewer adjustable components, and to be supplied with operating instructions (see also final paragraph).

'Sticking' of plastic in the screw is positively prevented as follows:

(i) Since there are here two screws rotating in opposite directions and both containing plastic (instead of one screw rotating in a cylinder as in conventional types), where particularly in the sticky state the cohesion of plastic to plastic exceeds that of plastic to metal, the material in the outer screw prevents the material in the inner screw from rotating with the inner screw, and *vice versa*.

(ii) Owing to the complementary variation of the depth of the grooves in the two oppo-

site screws, between maximum depth and zero (complete clean-out) for both correspondingly, there is a continuous enforced material-transfer from one screw to the other with a kind of peeling action from the one screw and winding-on action into or on to the other, particularly in the state where cohesion is large, which applies always to fresh layers of the total mass.

(iii) In the transfer zone there are the shear-mixing effects in three mutually normal planes, as described, affecting successively all the layers of the material.

The general new principle of control by making rotational speed adjustable as function of axial position can be applied (using some construction as shown in Fig. 8) to conventional extruders, to improve their performance, both for single-screw types, and for double or multi-screw types, also with intermeshing, and rotating in the same sense or in opposite senses, e.g. making in the latter case a section intermesh, and another not.

Generally.—With regard to the axial pumping effect of the construction:

(i) Both the screws, having opposite threads with opposite sense of rotation, move the material forward with their respective axial components of pushing.

(ii) Axial forward motion is further promoted through the interaction of the screws all round their circumference because due to cohesion, or due to friction and impact in case of working or mixing material with little or no cohesion, the material in the outer screw causes the material in the inner screw to have relative motion in the grooves, and *vice versa*, thus increasing the axial push of the screws.

(iii) Particles which slip backwards between lands are pushed forward again by the next land projecting across the path on account of the complementary changes of land-radii of the screws, acting like a pump.

(iv) Such particles as slip back are immediately caught up in the mixing zones (9), with rotations in three mutually normal planes, completing the working of these particles which was incomplete on account of their slipping back, and moving them forward through the above three effects.

This makes the principle applicable to design of a dynamic gland, indicated on Fig. 10, particularly for retaining fluids for which the pressure depends on the speed of rotation involved. This pumps out any fluid having penetrated, and sets up a pressure-equilibrium. Where such a gland might pump in some undesirable outer fluid, two glands in opposition should be provided. The complementary principle here introduced can also be applied to design of turbines and pumps, with a particular view to exploiting, or affecting each particle of the working fluids concerned, which is fundamental to raising efficiency.

A multi-mixer utilising the 'enforced order' mixing and control by adjustment of rotational speeds along the axis and in the radial direction, in series of mixers with separately positioned entries, in axial and radial sequence, is indicated in Fig. 9. This enables two or more mixing or chemical operations to be carried out simultaneously, though each under its own precisely controlled conditions regarding processing times, etc., on account of the independent adjustability of rotational speeds of components. The proceeds of such separate controlled operation can then be combined in a further controlled operation in a continuation section which is not shown, without permitting any time-intervals for harmful effects, e.g. oxidation or demixing to occur.

In general, with constructions producing mass-transfer and mixing between an inner and an outer screw, any combination of directions of helices, and of directions and magnitudes of angular velocities of screws,

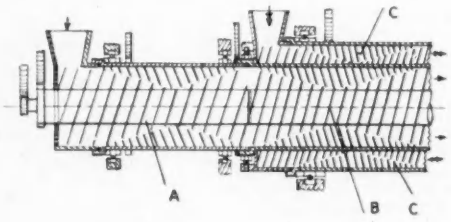


FIG. 9

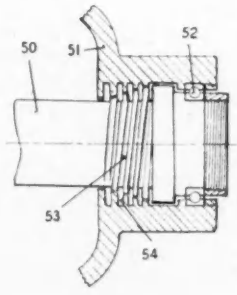


FIG 10

is applicable, together with, if required, two dynamic glands in opposition.

For the same screw-arrangement as in Fig. 1 (section 7) cyclic reversal of direction of rotation of both screws in an adaptation containing that one section only; or reversal of angular velocity of screws which may be cyclic, in a later section of a continuous machine (e.g. in the 3rd or 4th section of Fig. 7), will produce certain useful effects.

REFERENCES

(1) Frenkel, M. S., *Machinery*, 7 May 1954, 'Improved Methods for Working Materials in the Plastic State,' Fig. 1 (X).
(2) Grant, D., and Walker, W., (*I.C.I.*), Plastics Progress 1951, 'Mixing in Extrusion,' Fig. 5.
(3) McKelvey, J. M., and Bernhardt, E. C. (Dupont), *S.P.E. Journal*, March 1954, 'Adiabatic Extrusion of Polythene,' Figs. 3 and 9.
(4) Gore, W. L. (Dupont), *S.P.E.Journal*, March 1953, 'Principles of Plastics Screw Extrusion,' p. 8 (Developments).

Laporte Industries

A Year of Marked Expansion

THE directors of Laporte Industries Ltd. have recommended a final dividend on the ordinary stock of 11 per cent, less tax, at 8s. 6d. in the £, making a total of 16 per cent for the year ended 31 March. The AGM is to be held at Winchester House, Old Broad Street, London E.C.2, on 7 July.

In his statement Mr. L. P. O'Brien, chairman and managing director, announced that the company had acquired the total issued share capital of The Fullers' Earth Union. In the last two years The Fullers' Earth Union had spent £431,614 on new plant and buildings, and modernisation projects are to be continued. These include modernising plant for the preliminary treatment of earth with the object of decreasing production costs, and building new research laboratories at Redhill, Surrey.

The year 1954 was one of marked expansion of the Laporte group. In that period it acquired the Cleckheaton Chemical Co. Ltd., and its subsidiary, the Bierley Chemical Co. Ltd. In February A. W. Brook Ltd. was acquired as a selling and distributing organisation for the Midlands.

Capital projects in hand are considerable and will involve nearly all subsidiaries. There is a plan to construct a plant for producing hydrogen peroxide by the autoxidation process. Meanwhile, modifications of the electrolytic plant at Luton should yield extra output of hydrogen peroxide in the coming months.

Output of titanium oxide last year was increased, and to meet growing demands both at home and abroad, a new plant is being built to duplicate the output at the Stallingborough works. Titanium plant extensions will involve a capital expenditure of £290,000.

In Australia the Laporte Chemicals (Australia) Pty. Ltd., met delays in plant extensions which interferred with production with the result that trading was below that of 1953. Laboratory accommodation has been extended and the company will be able to step up production of various chemicals.

The consolidated income of the group, before tax, is £1,504,263 which includes profits of the Cleckheaton Chemical Co. Ltd., the Bierley Chemical Co. Ltd., and The Fullers' Earth Union Ltd.

Exothermic Reaction

CONTROL of an exothermic reaction is a problem that has long taxed chemists. It is a problem intensified by the increasing size of glass and chemical plant, since, when the size of a spherical vessel increases the surface area available for cooling does not grow in proportion to the volume.

When investigating this problem the development department of Q.V.F., of Stone, Staffs, considered the possibility of introducing heat transfer elements inside the vessel, and subsequently produced a unit which greatly simplified operation control while offering means of heat transfer independent of the containing walls.

A description of the new immersion heat exchanger is contained in a leaflet just published by Q.V.F. Three methods of operation are outlined. In the first the method of operation is to support the vessel in an electric heating mantle—used to start the reaction—later to be controlled by varying the water throughput to immersion heat exchanger. Though primarily developed as a cooler, the exchanger is also suitable for use as a steam heater.

This ability permits a second method of operation of applying steam for the initial heating and start of reaction, followed by the introduction of water for subsequent control. In the third method the unit can be used in conjunction with an electric heating mantle to accelerate heating-up.

Boots Record Year

Four Subsidiaries Pay First Dividend

MAGNIFICENT is the word Mr. J. P. Savage, chairman of Boots Pure Drug Co., used to describe the company's activities last year. Sales reached £60,000,000 for the first time. This figure is almost double that recorded seven years ago, and is nearly five times the pre-war figure. Profit went up from £3,116,451 to £4,214,758. After provisions for tax the net profit is £1,912,142, compared with £1,176,296. A dividend of 17½ per cent is proposed, making 27½ per cent for the year. Profit has gone up by a third, and the increase in dividend is modest. But Boots are putting a bigger proportion of profits to reserve.

Saying that much of the work of the research department was unspectacular, Mr. Savage paid tribute to its contributon to the company's efficiency. To emphasise the importance Boots place on its research, Dr. Gordon Ivan Hobday, Director of Research, was appointed to the board. Major new discoveries last year were the development and marketing of two new products, Chlorocide and Ethidium Bromide. This year Safersan will be added to the list. The result of six years' research in which more than 3,000 drugs have been tested, Safersan is a remedy for round worm in pigs.

For the first time the company received dividends from its subsidiaries in Australia, New Zealand, Pakistan, and Fiji. It also embarked on a new kind of venture overseas. With the Imperial Cold Storage & Supply Co. Ltd. of South Africa it formed a new company, Biochemico (1954) Pty. Ltd. to produce medical products of interest to both companies. Biochemico is already producing the first insulin made in South Africa. The company also produces Diosgenin, the basic material from which cortisone and hydrocortisone are made.

At the AGM at Nottingham on 14 July a resolution to increase the authorised capital to £15,000,000 will be moved at an extraordinary general meeting.

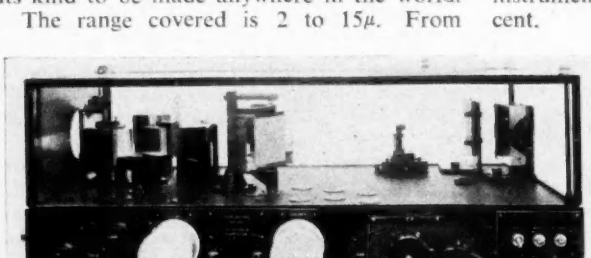
Terylene Headquarters

Among the 250 guests at the opening of Imperial Chemical Industries' Terylene headquarters at Harrogate, Yorkshire, last week were representatives of universities, industry and Government departments. Dr. Alexander Fleck, K.B.E., chairman of I.C.I., officiated at the ceremony. In his speech, Dr. Fleck warned against the assumption that Terylene problems were over and that it was merely a question of more plants leading to more sales and more profits.

General Purpose Spectrometer

WHAT is considered to be an important step in infra-red spectroscopy is the general purpose Grating Infra-Red Spectrometer, which is now in production by Sir Howard Grubb, Parsons & Co., Walker Gate, Newcastle-on-Tyne 6. This instrument, which was shown at this year's Physical Society Exhibition, is claimed to be the first production model of its kind to be made anywhere in the world.

The range covered is 2 to 15μ. From 2 to 5μ a CaF_2 prism is, while for the remainder of the range a prism of NaCl is used. For the range 5 to 15μ (first order) the scale is said to be accurate to about 0.002μ. For the higher orders the accuracy is correspondingly greater. At a recording speed of 1 micron per second the resolution is 3 cm^{-1} in the first order. At somewhat slower speeds a resolution of 1 cm^{-1} can be obtained over the whole range of the instrument. Stray light is less than one per cent.



The Grubb-Parsons Grating Infra-Red Spectrometer

British Instruments On Show

Many Important Advances at Earls Court Exhibition

THE multiplicity of observations, readings and measurements necessary for the running of a modern industrial plant make the provision of some sort of automatic control essential. The works engineer must have at his fingertips information concerning the operation of each separate part of the organisation under his control. These two subjects, automatic control and automatic recording, will be the theme of many of the stands at The British Instrument Industries Exhibition which will be held at Earls Court from 28 June to 9 July.

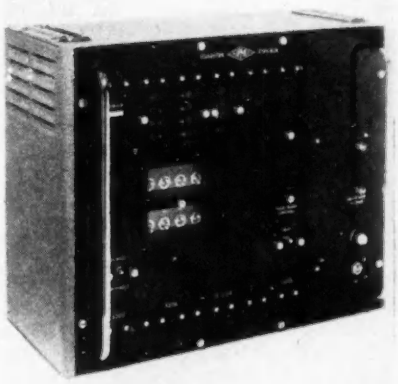
If the forecasts made by some firms come true, and there seems no reason why they should not, it will be possible for one man to see at a glance exactly how his plant is running, what faults have developed or are developing, the rate of output and the total output to date. It would appear that the time is not far off when the only equipment needed by the works' engineer is an armchair and a telephone.

Important Advances

But this is not the whole story. There have been important advances in instruments for more fundamental work. Three firms are exhibiting vapour phase chromatographs. There have been big developments in glassware, especially in interchangeable ground glass joint apparatus. Balances improve every year, becoming easier to operate, more accurate and more rapid.

As well as the more spectacular aspects of the exhibition, there are the old and tested instruments; meters, thermometers, pyrometers, chronometers, in all of which improvements are being made; improvements which often go unnoticed. It is perhaps these improvements that, in the long run, are the most important.

Counting, packing and measuring problems can often only be solved effectively by electronic means. The batch counter type N.808 made by **Airmec** (Block F, Stand No. 9) will count accurately and reliably at speeds many times greater than by any other method. This equipment can be used to control a wide variety of machinery. It will, for example, count the number of articles going into a container and when the correct number is received it will operate a trap door or chute and deflect the stream of articles into the next container. The maximum speed depends on the nature of the material being counted and on the sub-unit used with the counter, but is claimed to exceed 1,000 per second.



The Airmec Batch Counter Type 808

Airmec will also be showing a temperature control unit and a photocell and light source unit. The temperature control unit enables any temperature in the range 96 to 428°C to be maintained constant with a high degree of accuracy.

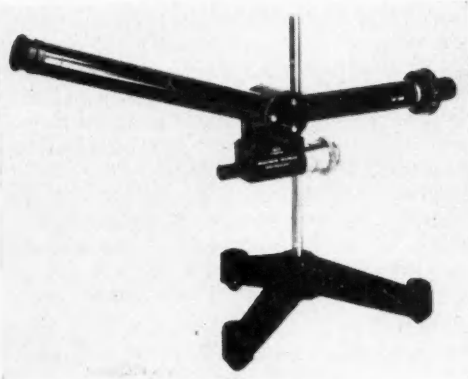
Among other exhibits of **Baird & Tatlock** (Block F, Stand No. 10) will be four precision balances. These are of similar appearance and overall dimensions and have many components in common, thus reducing the selling price. Sensitivity is 0.1 mg./division.

Baird & Tatlock are also showing a magnetic mercury cathode electrolytic analysis apparatus which has been designed in co-operation with BISRA. This will remove from solution quantitatively such elements as iron, chromium and nickel, leaving a residual solution which can be used for the determination of trace elements such as aluminium or titanium, vanadium or zirconium.

A new method of packing sheets of filter paper for chromatographic work will be on show by **W. & R. Balston** (Block F, Stand No. 32). In this type of work it is essen-

tial that the sheets be kept clean after the packets have been opened. Experimental glass fibre paper and ion exchange paper will also be on view. The first of these offers good filtering properties, while the second provides a useful complementary analytical method to the conventional filter paper chromatogram.

Introduced for the first time on the stand of **R. & J. Beck** (Block A, Stand No. 6) will be the reversion wavelength spectroscope. Beck's are well known as makers of all types of optical equipment and they will be showing a wide range of microscopes, varying from the simplest models for students' use to those suitable for the most exacting research, including some for use with phase contrast illumination. Other microscopes on show will include petrological microscopes, dissecting microscopes, micrometer microscopes and process microscopes.



The R. & J. Beck Reversion Wavelength Spectroscope

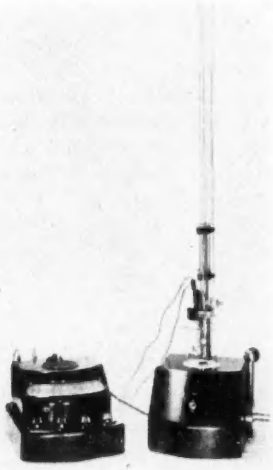
Photo-electric refractometers could be of immense assistance in processes where the refractive index is used as a criterion of the state of the reaction. It would be possible to observe the state of the reaction from a distance and to have a record of the whole course of the process. Also, by suitable presetting, it would be possible to give an indication of the end of the process or to stop the process automatically. **Bellingham & Stanley** (Block C, Stand No. 6) will be showing suitable instruments for this purpose. It is hoped that these instruments may also be used to apply automatic control so that a process may be controlled within prescribed limits. Much work still needs to be done, and extensive field tests must be carried out.

At least 24 different types of relay will be shown by **Besson & Robinson** (Block C, Stand No. 12a). Among new types are an impulse-operated memory relay and a miniature mercury switch relay, the J.02. This relay, which is about the size of two match boxes, has one or two 10 amp. switches and is suitable for AC or DC operation.

Newcomers to the instrument manufacturing industry are **Black Automatic Controls** (Block A, Stand No. 29) who are developing ranges of solenoid valves, pressure switches and thermostats. The solenoid valves are of the glandless type and are suitable for oil and gas burner control and other applications. Gas valves are available in a range providing adjustable by-pass for high- and low-flame working, while the shut off valves are also available if required with an adjustable position switch. This provides electrical contact when—and only when—the valve is fully closed, thus allowing signalling or safety control arrangements to be incorporated. The pressure switches, which will be on show, feature a small, neat micro-switch which is capable of handling adequate current. Thermostats for use with industrial equipment will also be shown.

Dial type thermometers for all purposes will be exhibited by the **British Rototherm Company** (Block C, Stand No. 15). An interesting example is the dual pen recorder model 1012. This can be used to give record of either two temperatures, or one temperature and one pressure or one wet and one dry bulb for hygrometer readings. These recorders operate on the mercury-in-steel system, comprising a coiled steel Bourdon tube, a capillary and a temperature sensitive bulb. The Bourdon tube drives the recording pen directly, thus eliminating all possibility of backlash.

Routine determinations of properties and constitution are an important feature of modern industrial processes, and the **Cambridge Instrument Company** (Block F, Stand No. 20) claim to be pioneers in this field. The Cambridge electro-titration apparatus has been completely redesigned and now includes a magnetic stirrer. This permits the motor to be placed underneath the platform where it is better protected and does not obstruct the electrodes or the



The Cambridge Electro-titration Apparatus

burette. The speed of the motor can be varied, thus enabling small quantities of liquid to be stirred without splashing. The burette and the electrodes can be raised away from the beaker by the operation of a lever.

The Cambridge corrosion voltmeter has been designed for field use. It measures the small electric potential existing between a structure and the soil, thus enabling an accurate estimate to be made of the location and extent of corrosive action.

The eventual replacement of ordinary analytical distillation by gas-liquid chromatography is forecast by **C. F. Casella** (Block F, Stand No. 33). In the gas-liquid chromatography apparatus developed by this company two columns are used, one containing the mixture to be analysed, the other being a control column.

An inert gas (usually nitrogen) is passed through both columns, the lower ends of which terminate in a copper block which is drilled in a manner analogous to a Wheatstone bridge. A change in the density of the gas-vapour mixture from the chromatogram column causes a flow along a horizontal passage. A sensitive thermo-electric flow detector is contained in this passage, the output from which is amplified and fed to a potentiometric strip-chart recorder. A wide variety of substances can be analysed as the temperature range is from 20°C to about 300°C.

A portable thermocouple potentiometer will be shown by the **Croydon Precision Instrument Company** (Block C, Stand No. 7). This robust instrument is suitable for temperature measurements with all thermocouples and for calibrating the indicating instruments that are used with thermocouples. Two ranges are available, one for base metal couples and one for precious metal couples.

Laboratory furniture for a wide variety of purposes will be shown by **Cygnet Joinery** (Block F, Stand No. 27). Considerable flexibility of layout can be obtained by use of equipment from the standard range of products. A special feature are steel reinforced bench tops which can be made in acid- and heat-resisting hardwoods. A new development is the design and supply of special fume cupboards for work on radioactivity.

Perhaps the largest research groups in the country are those controlled by **DSIR** (Block A, Stand No. 14), and some of the advances in instrumentation made by these groups will be on show.

What is believed to be one of the most sensitive galvanometers ever constructed has been designed by the British Welding Research Association. This is the catenary galvanometer which is used for the recording of small temperature variations by means of thermocouples. Designed as a storing galvanometer it has sufficient sensitivity to give full-scale deflection with a temperature range of $\pm\frac{1}{2}$°C. When used under conditions where damping is not necessary this instrument can readily detect 10^{-9} amp.

The British Coal Utilisation Research Association has produced a total heat meter, a calorimeter type instrument which gives the total heat of a gas directly and its temperature by inference. This should be of in-

The Cambridge Corrosion Voltmeter

terest to all industries using furnaces in which it is important to know the gas temperature since it is said that there is no similar instrument available for this purpose.

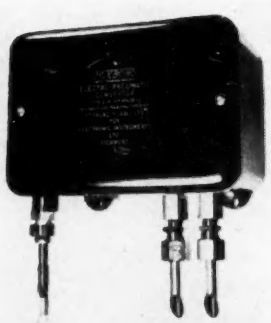
Electronic level control units will be shown by **Elcontrol** (Block A, Stand No. 28). Both single- and double-stage units are available, the latter combining the functions of two single units. An especially sensitive model has been developed for use with liquids of low conductivity, and an extended range of probe fittings has been designed, including a robust fitting for use in pressurised vessels operating at high temperatures.

A new style of construction is a feature of all but the smallest Elcontrol units. The chassis is readily withdrawable and plugs into a deep drawn steel case provided with a hinged lid. Installation and servicing are greatly simplified by this arrangement.

It is claimed by **Electroflo Meters** (Block F, Stand No. 18) that they can undertake the complete instrumentation and/or control of all types of industrial power and processing plants, and their stand will be designed to show this.

A small control station measuring approximately ten inches square and consisting only of a telephone type dial, a reading instrument with a four-inch scale, and alarm lamps, can be used to monitor any number of remote processes. All that is necessary to obtain a reading is to dial the appropriate number. This is accomplished using only two wires, or three, including a compensating lead, if temperature readings are required.

Electronic Instruments (Block A, Stand No. 4) in collaboration with **Foxboro-Yoxall** have designed and marketed an electro-pneumatic converter which enables pneumatic *p*H recording and control to be obtained without the interposition of an electronic potentiometer. This results in a considerable saving in cost and enables simpler and more robust mechanisms to be used. This converter is designed to be coupled to the EIL industrial *p*H meter, and the output from this meter, which normally ranges from 0-15 *p*H, produces a corresponding air pressure change of three to 15 psi.



The Foxboro Electro-pneumatic Converter

A useful instrument where specimens cannot be brought to the laboratory is the portable *p*H meter, model 30, which is a small, compact instrument containing its own batteries and all accessories needed to make a complete *p*H determination on the spot. Another useful *p*H meter is the direct reading model 23A. This instrument can be used by unskilled personnel as once it is standardised it is only necessary to dip the electrode system into the solution being measured and note the *p*H reading on the scale.

The latest type of electronic digital computor will be shown in action on the stand of **Elliott Brothers** (Block D, Stand No. 6). The Elliott automatic readout unit will also be in action and will be continuously recording on an electrical typewriter variables which will be indicated at other points on the stand. This unit can also undertake the addition or continuous integration of any of the measured quantities and indicate when any of the variables deviate from their set points.

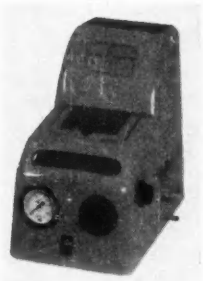
In the chemical section will be shown the Elliott-Bendix ultra-viscoson equipment, which is now being manufactured in this country, for the measurement of viscosity by means of ultra-sonic oscillations.

Volumetric glassware, with coloured etched graduations which are claimed to be virtually indestructible under normal conditions, will be shown by **H. J. Elliot** (Block A, Stand No. 12). This company will also be showing a new automatic tilt measure which is available in two sizes—2-5ml. and 4-15ml. This new design is claimed to have greater accuracy and to be cheaper than the orthodox Kipps measure.

A new development to be exhibited by **Endecotts** (Block F, Stand No. 34) is a portable field sieve. This sieve is 12 in. square and is supplied with interchangeable bottoms of any specified mesh. The screens are held in place by quick action clamps

and can be quickly changed from one mesh to another. A range of test sieves, which conform to British and American standards, will also be shown, together with pocket Interchanger sieves.

The 'EEL' flame photometer will be one of the exhibits of **Evans Electroselenium** (Block D, Stand No. 11). Originally developed for medical work, it has many applications in industry where time saving is of prime importance. It is reported that one user was able to carry out in eight hours determinations which would have taken a month by conventional methods. This instrument is coming into increasing use for rapid determinations of sodium, potassium, lithium and calcium.



The EEL Flame Photometer

Among other exhibits being shown by Evans are an H_2S meter and an exposure controller which is designed to provide constant conditions of photographic exposure.

Some of the possibilities of automatic process timing will be demonstrated by **Everett, Edgcumbe** (Block B, Stand No. 19). In conjunction with this will be shown recording instruments for monitoring the actual operation. A new design of operation recorder is incorporated in which each pen has three positions. This may be used, for example, for showing running time, working time and idle time for a series of machines.

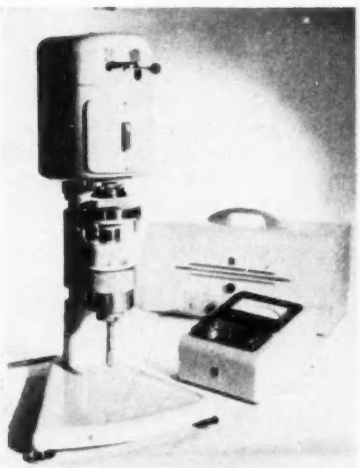
New designs of Synclock synchronous motors will also be shown. The speed of these motors is directly dependent on the frequency of energising alternating current. They have many applications in timing devices, chart drive mechanisms and process control.

The measurement and control of temperature, flow and pressure, and liquid levels is the theme of the **Evershed & Vignoles** stand (Block E, Stand No. 10). The In Line Scanner consists of shadow type indicators arranged close together so that the pointer shadows form a continuous line. In this way the stability of a plant can be seen at a glance; any deviation from normal conditions is immediately apparent to the operator. This equipment is mounted on a control desk, together with miniature indicators and recorders, and auto/manual control stations.

Temperature measurement instruments include a radiation roof pyrometer, an electronic thermocouple repeater and a BTU meter for high-pressure hot water.

Electronic digital computers are coming to be regarded as essential aids to calculation in all branches of science and industry. The **Ferranti** 'Pegasus' computer (Block F, Stand No. 5) is suitable for carrying out a wide range of calculations and investigations. Emphasis has been placed on facilities which simplify the preparation of material for calculation. Punched paper tape is used for the input and output of information.

Ferranti are also showing the Ferranti-Shirley viscometer which is a precision instrument of the cone and plate type for laboratory use. It provides a continuously variable rate of shear over a wide range, making it extremely useful for the study of non-Newtonian materials. Finally, a mention should be made of the Tesvac HV high-



Ferranti-Shirley Cone & Plate Viscometer

frequency vacuum tester. This provides a rapid and convenient means of estimating the degree of evacuation of glass vessels during the pumping process.

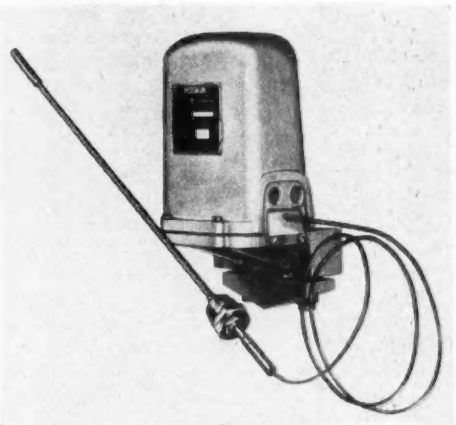
Fielden Electronics (Block B, Stand No. 9) consider that they have the best solution to the problem of automatic plant supervision in 'Frances', a 50 point print-out scanner. The equipment, which is still being developed, consists basically of a DC potentiometer and a 50 point stepping switch which examines 50 variables in turn. Fifty set point voltages can be set up and the instrument measures the difference between these voltages and those obtained from the plant. No action is taken as long as these are the same. When a difference is found a relay operates which connects a servo motor so that the potentiometer balances, showing either the variable voltage or the difference between this and the set point voltage. At the same time this value is recorded on a paper strip.

Also to be shown by Fielden is the proximity meter type PM.4. This uses the determination of electrical capacitance as a means for measuring a wide range of quantities. This meter is of great use when no physical contact with the material to be measured is possible, as for example in moving machinery.

Despite all the recent electronic gadgets that are appearing in laboratories, glass is still the basic constructional material for most apparatus. **W. G. Flaig** (Block F, Stand No. 2) makers of the Exelo range of glassware will be showing some of their latest developments.

A new vacuum desiccator made in Davisil borosilicate glass is available in three sizes. Features of the design include an entirely new type of stopcock which gives greater strength, interchangeable joints to BS specification, and interchangeable lids.

Foster Temperature Indicating Controller with Electronic Control System



The New Foxboro Model 12A Temperature Transmitter

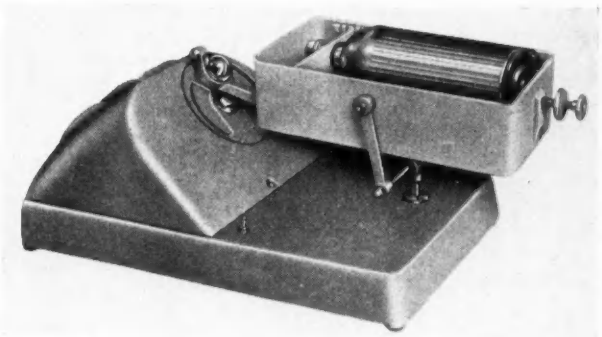
The Exelo Scholander micrometer gas analyser is an improvement on the design originally described by Scholander in 1947 (*J. Biol. Chem.* 1947, **167**, 235-50). The accurate determination of respiratory gases is possible at the rate of three or four analyses per hour, and the instrument will handle quantities of gas of the order of ½ to 1½ ml.

Continuous-balance potentiometric indicators and recorders will be shown working on the stand of **Foster Instruments** (Block C, Stand No. 9). A feature of these instruments is the constant voltage mains unit, which gives a low voltage DC output constant to within 0.25 per cent for mains variations up to 10 per cent. The elimination of the dry cell makes periodic standardisation unnecessary.

Smoke density detecting, indicating and alarm equipment will also be shown. This apparatus works on the principle of interference by smoke of a constant intensity light source focused on to a photo-electric cell. Intronoscopes, which are claimed to be standard equipment in many industries, will also be part of the display of Foster Instruments. With one design of instrument it is possible to inspect the surface finish of holes ranging from ⅛ in. diameter upwards.

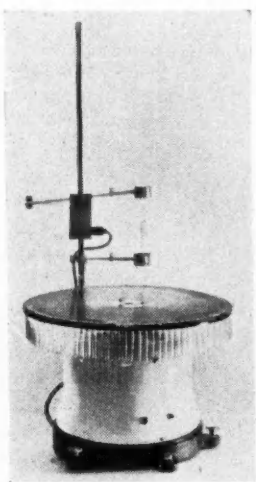
Centralised process control is aided by the temperature transmitter M/12A recently introduced by **Foxboro-Yoxall** (Block F, Stand No. 7). This is a non-indicating, narrow span, pneumatic, force balance

The New Gallenkamp super-shaker



measuring device which transmits a 3-15 psi. range signal proportional to the measured temperature. The transmitter is compact, light and completely weatherproof and may be mounted in any position. It is designed to be the complement of the Foxboro Consotrol recorder/controllers, which give visual indication and warning if necessary of the values of liquid levels, temperature, etc.

One of three new exhibits by **A. Gallenkamp** (Block D, Stand No. 9) will be a fraction collector for column chromatography. This will hold 100 × three ml., 84 × 10 ml, 54 × 25 ml or 44 × 50 ml collection tubes according to the collector plate used. Each plate has one collecting position in excess of the number quoted. This extra tube is intended to be connected to a reservoir, so that if the apparatus is left unattended and the cycle of collection is completed, the excess solvent can be collected. The fraction measuring device consists of a beam with a syphon measuring tube at one end and a counterweight at the other. The beam is adjusted to balance with the measure half full. This beam is used to control a mercury switch which operates the collector plate release. The movement of the plate is delayed until the measure is half full again so that drainage errors are eliminated.



Gallenkamp's Fraction Collector for Column Chromatography

Other new Gallenkamp developments are a 'Super-Shaker' which gives a three dimensional shake to bottles similar to that obtained by hand, but far more vigorous, and a pulp drying oven which has been designed in accordance with rules published by The Paper Makers' Association and The British Wood Pulp Association.

A newly developed distillation column has been manufactured for the research station of the British Petroleum Company by **Glass Developments** (Block B, Stand No. 6). It is designed to use various types of 'dumped' packings and the separation is claimed to be over 100 theoretical plates. Glass helices may be used for the separation of substances affected by contact with metal. The efficiency is reduced in this case to about 50 plates.

On the same stand will be exhibits by the Ultrasonoscope Company, an associate of Glass Developments. Their chief exhibit will be the Ultrasonoscope which is claimed to be the most versatile instrument for ultrasonic flaw detection. An important application of this apparatus is the measurement of wall thickness of metal vessels where inspection is possible from one side only, e.g., the measurement of corrosion of metal tanks.

The range of products to be shown by **Griffin & George** (Block D, Stand No. 8) is so wide that it is impossible to do justice to them in a short space. Perhaps the most important is the vapour-phase chromatographic analysis apparatus (see THE CHEMICAL AGE 1955, **72**, 1196) which enables analyses of mixtures of organic chemicals to be carried out much more rapidly than by conventional means.

Balances are also an important product of Griffin & George and all types will be displayed, including semi-micro aperiodic, analytical aperiodic, straight analytical, chemical, student and physical.

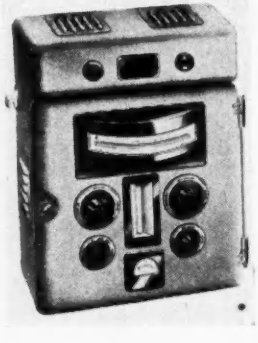
An interesting exhibit will be Courtauld atomic models which possess many advantages over older types of atomic models. They give greater flexibility of construction and produce more realistic results.

Chromatograms may be examined under ultra-violet light by using the Chromatolite fluorescent lamp manufactured by **Hanovia** (Block B, Stand No. 17).

A new oxygen meter will also be shown by Hanovia. This will readily detect changes in oxygen concentration of $\frac{1}{2}$ volume per million. Known as the Hersch Oxygen Meter, the apparatus was developed by the Baker Platinum Division of Engelhard Industries Ltd. The accuracy is claimed to be less than plus or minus five per cent of full-scale deflection, and the response to changes in oxygen concentration is almost instantaneous.

Modern applications of crystals call for great precision of relationship between surface and lattice planes, and the ordinary quartz goniometer does not possess sufficient accuracy for this purpose. A quartz crystal goniometer developed by **Hilger & Watts** (Block F, Stand No. 10) has been designed to meet these new requirements. This instrument is of simple and robust construction and is claimed to be capable of an accuracy of one minute of arc for practically unlimited periods of workshop use. The detector is a Geiger counter which operates a lightly damped rate of count meter. A sensitivity control is provided to accommodate the instrument for a wide range of intensities of reflection.

Hilger & Watts will also be showing miniature X-ray diffraction cameras for use with the Hilger micro-focus X-ray unit. These cameras possess high resolution and accuracy.



The new Hersch Oxygen Meter to be shown on the Hanovia Stand

What is described as a miniature exhibition in itself will be displayed by **Integra, Leeds & Northrup** (Block E, Stand No. 1). This will consist of 18 panel mounted instruments, all working. Among the range of products manufactured by this company may be mentioned; pH electrodes, electrolytic conductivity cells, thermocouples, smoke samplers, tachometers and gas analysis cells.

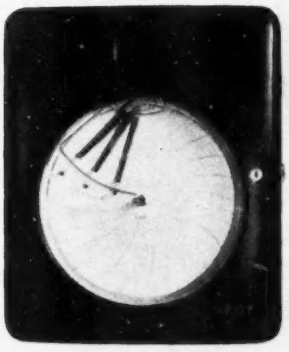
Safe, controlled heating for laboratories, and pilot and production plant is provided by the 'Isomantle' electric heating mantle, on show by **Isopad** (Block F, Stand No. 29). This consists of resistance wire interwoven with glass fibre for temperatures up to 400°C, and with quartz cloth for temperatures up to 800°C. A new development is the Isopad system of combined resistance and mains frequency induction heating which allows loadings up to 2 kW per square foot. On display will be the main component parts of such a unit for a 400 gallon distillation plant operating at temperatures up to 375°C.

Volumetric flasks and cylinders with interchangeable ground-glass stoppers have been introduced by **James A. Jobling** (Block A, Stand No. 7). This should mean a great saving in time since it will not be necessary to re-unite each flask with its own particular stopper once they have been separated. A new range of semi-micro apparatus will also be on show which has been specially developed for use in schools and technical colleges. These new Pyrex products were shown earlier in the year at the Science Masters' Association Exhibition.

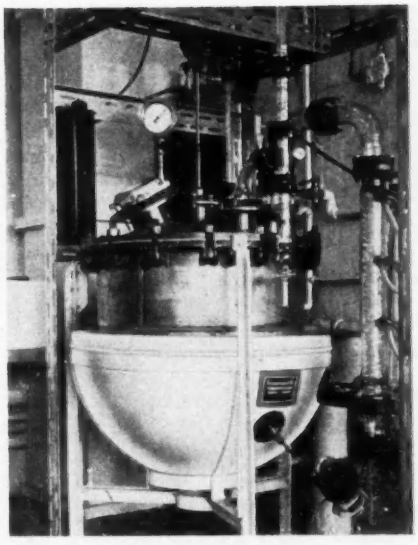
KDG Instruments (Block A, Stand No. 22) will be showing a range of new instruments, including high-pressure differential pressure gauges and switches, flow switches, flow indicators and temperature controllers. Working models of hydrostatic tank contents gauges and controllers, and temperature controllers will also be shown.

A new instrument which provides all the information necessary for maximum fuel economy conditions to be maintained is the Econometer which will be demonstrated by **Kelvin & Hughes** (Block F, Stand No. 12). This company will also be exhibiting a variety of other industrial equipment, including a three position electronic temperature controller, a flaw detector, and strain recording equipment.

Commander-Class instruments will be exhibited by **George Kent** (Block F, Stand No. 17). These instruments, which are built up from interchangeable elements, include the KUP, KUX and KUS flow meters, which are based on the KU mercurial flow meter, as well as the KP which uses up to three Bourdon tubes for pressure measurements, and the KR series which use a mercury U tube or bellows unit for the remote reception of flow values from a primary measuring and pneumatic-transmission device. The ease of interchangeability of mechanisms and sub-assemblies is fully maintained in the new instruments, making for great convenience in use.



Kent Commander Class KP instrument for recording three pressures simultaneously

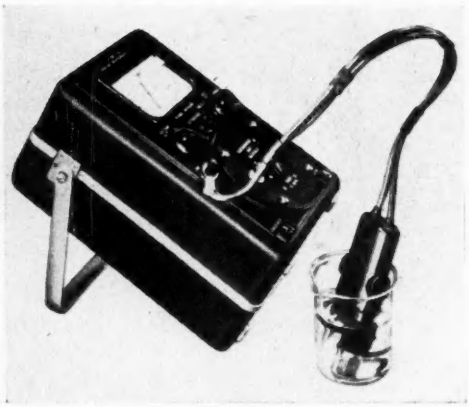


An Isomantle fitted to a 30-gallon stainless steel reaction vessel for use in a flameproof area

A working assembly of an industrial bubble-cap column in glass will be one of the exhibits of the **Loughborough Glass Company** (Block A, Stand No. 15). This apparatus, which we have previously described (see THE CHEMICAL AGE 1955, **72**, 955) is equally suitable for fractional distillation, concentration, gas scrubbing and absorption.

Double distilled water can be produced by using two Loughborough all-glass stills working together. One of these stills by itself will produce water conforming to BP 1953 requirements and pyrogen-free. Also on show will be soxhlet assemblies which incorporate a solvent trap which speeds up the process of soxhlet extraction and reduces the risk of fire. Among other exhibits will be Teflon sleeves for use with ground glass joints when it is chemically inadvisable to apply grease to the joints.

Marconi Instruments (Block B, Stand No. 1) will be showing a wide range of electronic equipment. The moisture meter TF 933A is designed for the rapid measurement of the moisture content of a variety of materials, particularly those of organic origin such as grain, seeds, flour, tobacco and paper. A compression test cell is used which elimi-

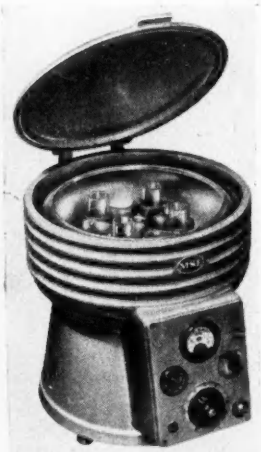


The Marconi portable pH meter, TF 889

nates packing errors and minimises the effect of uneven moisture distribution.

The Marconi *p*H meter TF 889 is a direct-reading instrument complete with protected glass electrode assembly. It is battery operated and covers the *p*H range 1-11 with a discrimination of 0.05 *p*H. This instrument can also be used with standard laboratory types of electrodes.

What is claimed to be a completely new range of centrifuges is being shown by **Measuring & Scientific Equipment** (Block C, Stand No. 16). The MSE 'Multex' centrifuge is of a size and type which has long been required by medical and industrial laboratories, and will take up to 32 tubes. It will operate at consistently high speeds whatever the loading conditions.



The MSE 'Multex' centrifuge

For low temperature work MSE are exhibiting five refrigerator centrifuges. One of these, the 'Major Refrigerator', will take containers up to 1,000ml in size, while another, the 'Superspeed 20 Refrigerator,' will operate at speeds of 20,000 rpm.

MSE are also showing their range of homogenisers, blenders and microtomes. The MSE homogeniser has facilities for cooling, which is an important feature where temperature rises have to be counteracted.

The Mervyn-Harwell Square Wave Polarograph has previously been described in this journal (see THE CHEMICAL AGE 1955, **72**, 936). This instrument will be on show on the stand of **Mervyn Instruments** (Block E, Stand No. 11) together with several other important instruments, including the Mervyn-NPL Infra-Red Spectrometer. This apparatus is now fitted with interchangeable detectors and filters and can cover the range 1-4μ. In the lower part of this range the resolving power is claimed to be one wave number, while at the opposite end three wave numbers are easily possible. The instrument will resolve the structures of all solids, liquids and gases within its range. Many improvements have been made in the electronic circuits to ensure maximum reliability in use.

On show at the stand of **Metropolitan-Vickers Electrical** (Block F, Stand No. 24) will be the Vapour Phase Chromatograph which has previously been described in this journal (see THE CHEMICAL AGE 1955, **72**, 936 and 1196). This instrument can be used for separations of many different types of compounds, as well as for analyses of mixtures after previous calibration.

A particle counter and sizer will be on show at the **Mullard** stand (Block C, Stand No. 10). This analyses photomicrographs of powder samples. Demonstrations will also be given of a range of electrochemical equipment, including a conductivity bridge, conductivity controller and associated cells, and potentiometric titration apparatus.

The heart of any number of electronic instruments is a permanent magnet and **Murex** (Block B, Stand No. 5) will be showing some of the latest developments in this field, including the production of multipole

Metropolitan-Vickers vapour phase chromatograph

anisotropic annular magnets. The range of Sincomax magnets, in which the soft iron pole piece is sintered together with the magnetic alloy as an integral unit, has been extended to include the smaller centre pole type of magnet.

Fabrications in pure tungsten, molybdenum, tantulum and zirconium will be shown, together with recently produced pure niobium sheet and tube. There is an increasing demand for these pure metals as constructional materials in the electronic and other industries.

The Reid vapour pressure recorder, which was developed by I.C.I. at Billingham will be exhibited by **Nash & Thompson** (Block B, Stand No. 7). This instrument will record automatically the Reid vapour pressures of petroleum fractions. Two models are available, one of which will draw a sample from one source at intervals of 20 minutes, and another which will draw samples from two sources at intervals of 30 minutes. The recorder has been designed as a plant instrument and is fully flame proofed and suitable for use in the danger areas of refineries. This present instrument will record vapor pressures in the range 2 to 18 psi. A further model is proposed for the recording of vapour pressures up to 250 psi.

On the same stand will also be shown organic crystalline and plastic scintillators, such as *p*-terphenyl plus tetraphenyl butadiene and similar mixed phosphors. Crystals of sodium iodide and anthracene in a variety of shapes and sizes will also be on view.

Negretti & Zambra (Block F, Stand No. 16) will be exhibiting examples of all their wide range of products. These include remote set controllers, mercury in steel thermometers, pyrometers and resistance element temperature indicators, and pressure indicators and recorders.

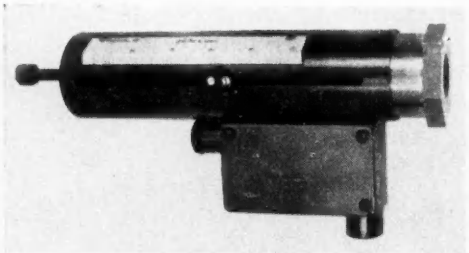
Automatic titrations can be performed by the automatic titrator manufactured by **W. G. Pye** (Block F, Stand No. 4). This instrument consists of an electrically-operated two-speed burette tap controlled by a *p*H meter which indicates the end point of the titration. The end point can be set to any *p*H value with a stability of ± 0.1 *p*H units. The change over from fast to slow can anticipate this end point by up to five *p*H units.

Improvements have been made to the two dimensional measuring microscope. This instrument will measure to 0.01mm over a rectangular field of area 200 sq. cm. Magnifications of $\times 5$ or $\times 20$ can be obtained.

A portable organic preparation laboratory which will pack into a suitcase will be shown by **Quickfit & Quartz** (Block C, Stand No. 19). Other exhibits will be counter-current extraction machines, a kit of 19 standard Quickfit glass components which can be assembled in various combinations to form over a dozen different sets of apparatus, and a variety of apparatus for evaporation, including a climbing film evaporator, a rotary film evaporator, and a circulatory-cyclone evaporator having a throughput of five litres per hour. Many of these products have previously been described in this journal (see THE CHEMICAL AGE 1955, **72**, 985).

On show for the first time is a new thermocouple head made by **Sifam** (Block C, Stand No. 27). It is claimed that this obviates the practical and technical difficulties frequently encountered in the use of thermocouples. The compensating cables which are supplied can be provided with coverings to withstand the most rigorous conditions. Some other important features are: no loose screws or parts, easy access to terminals, use of robust aluminium castings to withstand hard usage, and continuity of thermocouple wires and compensating leads, avoiding errors due to temperature gradients in the head.

Solway Flowrators (Block F, Stand No. 18) have extended their range of flowrators up to size 12 with a capacity of at least



The Solway Flowrator mercury switch alarm device

10,000 gallons per hour. At the other end of the scale are the tri-flat tubes which permit accurate measurement down to about ¼ ml/min.

The major new feature of their equipment is the adjustable mercury switch alarm device which can be attached to most flowrators, providing alarm when the rate of flow falls below a certain value, or alternatively when it exceeds a certain value. Two switches can be fitted to give both high and low alarms.

A new range of precision balances will be shown by **Stanton Instruments** (Block A, Stand No. 26). These incorporate refinements in both appearance and performance. Also on show will be thermo-recording balances. Stanton claim that their new catalogue is the most comprehensive catalogue of precision balances ever printed.

Sunvic Controls (Block C, Stand No. 17) are well known for their range of Nullmatic process control instruments, and a representative selection of these will be on show, including several new introductions, notably a 'plug-in' controller and M/P station and a new miniature pressure regulator, together with a leak detector for the detection of minute leaks in castings, etc.

Apparatus of a more purely scientific nature will include a pulse height analyser, resistance thermometers, controllers, thermostats and relays.

A resistance-capacity bridge designed to give quick and accurate measurements of resistance or capacity at mains frequencies will be shown by **Taylor Electrical Instruments** (Block A, Stand No. 27). By means of eight ranges it is possible to measure capacities from 0.00012 to 1,200 microfarads and resistances from 12 to 120,000 ohms and 1.2 to 120 megohms. Apart from these the company will also be exhibiting a complete range of moving coil and moving iron panel meters, and a range of six multimeters.

Designed by the National Institute for Medical Research and manufactured by **J. W. Towers** (Block F, Stand No. 15) is the automatic fraction collector for use in chromatographic analysis. The turntable of this apparatus will accommodate 100 collecting tubes and is driven by a motor controlled by a relay which is operated by a siphon balance. This apparatus can also be used in conjunction with the Towers countercurrent apparatus which is used for carrying out the technique of countercurrent distribution between two liquid phases.

A direct reading balance will also be on show on this stand. This balance will weigh up to 200 gm. simply by the operation of four control knobs. Many other examples of Towers equipment will also be exhibited, including electric furnaces, magnetic stirrers and volumetric glassware.

Accurate temperature control is a feature of many of the exhibits of **Townson & Mercer** (Block F, Stand No. 14). The low inertia Warburg instrument can be used for all reactions where gas evolution needs to be known while a sample is shaken under constant conditions. Each sample, together with its manometer, is shaken about its vertical axis by a spring movement. The use of the latest immersed pump and regulator control enables much smaller quantities of water to be used, with very much quicker rates of heating and stabilisation.

The S.200 thermostat bath is claimed to be ten times more accurate at 100°C than any other production thermostat in the world. The latest model employs a stainless steel tank with double glass windows together with circular portholes in the opposite walls so that light can be passed through the liquid. The accuracy of these baths is such that it has been possible to measure radioactivity by calorimetry.

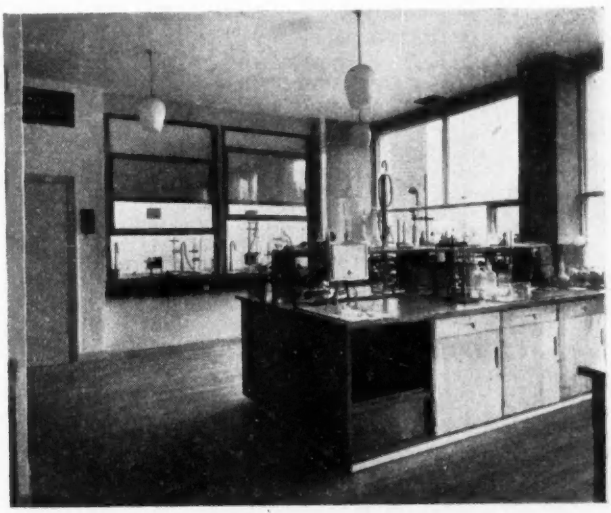
Unicam Instruments (Block F, Stand No. 4) announce that they will not be able to show the infra-red spectrometer or the new flame photometer as both these instruments have been on continuous exhibition on the Continent since the Physical Society Exhibition in April. They will, however, be showing examples of their range of ultra violet and visible spectrophotometers, to-

gether with crystallographic equipment, including the S.150 high temperature powder camera for X-ray analysis up to 1400°C and the S.65 powder camera.

The Hartley two-piece and three-piece funnels, which will be exhibited by the **Worcester Royal Porcelain Company** (Block E, Stand No. 2), are claimed to have several advantages over the ordinary Buchner funnel. They can be cleaned easily, and quantitative filtration is possible. At the request of a well-known micro-laboratory a micro-size version of this apparatus has also been made. Porous porcelain filter crucibles and funnels will also be shown, together with impervious sintered alumina crucible tubes, etc., which are a fairly recent introduction. These are capable of withstanding temperatures up to 2,000°C.

The New Laboratories at Liverpool University

In a recent issue we referred to the opening of the new inorganic and physical chemistry laboratories at Liverpool University by His Royal Highness, The Duke of Edinburgh. These two photographs clearly illustrate the spaciousness



and excellent natural lighting in the laboratories. The attractive benches and fittings as shown in the photographs were supplied by J. W. Towers & Co. Ltd. of Widnes. Architects were Stephenson, Young and Partners of Liverpool

Canadian Ammonia

Construction of Plant to Begin At Once

A NEW plant at Millhaven, Ont., for the manufacture of anhydrous ammonia was announced recently by Canadian Industries (1954) Limited. Construction of the plant, estimated to cost $9,000,000, will begin immediately with completion scheduled for late next summer.

Capacity of the plant will be 200 tons of ammonia per day, which will make it the largest ammonia plant in eastern Canada, able to meet C-I-L needs and those of other consumers. The plant will require a staff of approximately 100 employees and will cover 20 acres adjacent to the company's Terylene plant, which is just starting production of the first Canadian-made polyester fibres.

Coincident with the building of the ammonia plant at Millhaven will be an expansion of C-I-L facilities at Beloeil, Que., to manufacture ammonia solutions for use in agriculture. Raw material will be ammonia from the new plant. This new supply will make materials available to customers who are now required to import.

The Millhaven site was selected by the company because it is central to consumers in eastern Canada. It marks the second step in the development of chemical operations on the 1,400 acre location purchased in 1954.

Fuel oil is planned as the raw material for the C-I-L operation, but natural gas can be used if available. Since the recovery of ammonia from coke-oven operations in Toronto in the 1880's, C-I-L had been a manufacturer of the product on a small scale. This new operation substantially extends the company interest in ammonia.

Recent developments in the application of ammonia for industry indicate increased requirements for sulphite pulp, ore extraction, for the manufacture of petroleum catalysts, and, possibly, for the production of ethanolamines, cyanides, acrylonitrile and urea.

Continental Apparatus

TAKING place at the same time as the British Instrument Industries' Exhibition (28 June to 9 July) will be an exhibition by Hudes Merchandising Corporation Ltd., 52 Gloucester Place, London, W.1, of scientific instruments and apparatus of continental manufacture.

Sartorius-Werke of Germany, will be showing many of the latest types of balance including the new electronic balances. A representative will be available to discuss the latest trends in balance design.

Other exhibits will include a flame photometer from Dr. Lange of Berlin, a complete range of electrophoresis and chromatographic apparatus from LKB Produkter of Stockholm, the Sjostrand ultra microtome, some new electrically-heated porcelain apparatus, glass apparatus by Schott & Genossen, interference filters and a range of Zeiss microscopes and accessories.

Steam Power Plant

AN ATTRACTIVE book produced by Simon-Carves Ltd., Cheadle Heath, Stockport, gives some idea, not only of some of the work done by the company, but of developments in general in the field of boiler and furnace design.

'Steam Power Plant' is the title of the book for much of the company's work is concerned with the manufacture of steam generating equipment for power stations. During the war the company designed and manufactured the furnaces and boilers for two power stations in the USSR. All the equipment was packed and shipped to Russia where it was erected with Soviet labour and supervision to instructions provided by Simon-Carves.

The company has also been concerned in the construction of some of the largest power stations in this country, notably those at Accrington, Croydon and Northampton, to name a few.

B of T to Control Metals

REPLYING to a question by Mr. P. Roberts, Sir Anthony Eden, the Prime Minister, said the Board of Trade is to take over from the Ministry of Supply the control of the iron and steel and non-ferrous metal industries, and the engineering industry. The change will take place in about a month. An Order giving effect to the transfer in the case of iron and steel will be laid before the House of Commons shortly.

Announcing this, Sir Anthony Eden said the purpose of the change is to relieve the Ministry of Supply of duties extraneous to its prime task of supplying the armed forces, and to associate the Board of Trade more closely with certain major industries.

Analytical Chemistry of Nb & Ta

Part I—Basic Chemical Reactions

AT a meeting of the Midlands Section of the Society for Analytical Chemistry held on 6 April at the University, Edmund Street, Birmingham, B. Bagshawe, A.I.Met., from the Brown-Firth Research Laboratories, Sheffield, read a paper entitled 'The Analytical Chemistry of Niobium and Tantalum with Particular Reference to Steel and Allied Materials'. In opening the meeting, Dr. R. Belcher, vice-chairman of the Midlands Section, said that Mr. Bagshawe was already well known to the majority of those present. He had been a frequent speaker at meetings of the old Midlands Society for Analytical Chemistry, and in this respect had established a reputation second to none.

Mr. Bagshawe introduced his subject by saying that no one should attempt a paper on the analytical chemistry of niobium and tantalum without first paying homage to the late Dr. Schoeller. The work of Dr. Schoeller and his associates, notably Powell, Waterhouse, Jahn, Webb, Deering and others, to which they devoted themselves with single-minded purpose for nearly 20 years, in systematically elaborating the analytical chemistry of these two elements is a monumental classic of sustained investigation in what was previously a virgin and uncharted field.

Their work, recorded in dozens of original papers and in standard works (**1**) (**2**), had made Mr. Bagshawe's present task an easy and pleasant one, but also paradoxically an extremely difficult one. It was easy because there was no shortage of subject matter, difficult because so little remained to be said that had not been said with much more authority by one or other of these great investigators.

Some Recent Developments

There were, however, one or two more recent developments, notably in the development of selective colour reactions, chromatography, etc., and in this paper an effort was being made to correlate these with the classical foundation in bringing out the applications which are being found most useful in the ferrous metallurgical industry at the present time.

One of the first complicating features of tantalum-niobium chemistry is the extreme complexity of the ore and mineral groups. Fortunately these difficulties are not felt in full force by the metallurgical chemist, or at least by the steel chemist. They must, however, be faced by the minerals chemist, who meets a wide range of interesting element combinations, often further complicated by the minerals occurring as minor constituents in low grade ores. Examples of these are the low grade African ores, e.g. Sukulu soil—Uganda and Nigerian granites from which niobium mineral pyrochlore is extracted. Table I shows a typical series of pyrochlore analyses.

TABLE I

Pyrochlore: Typical Analyses

		1	2	3	4	5
Niobium Pentoxide	Nb_2O_5	53.2	58.3	47.1	58.8	55.2
Tantalum Pentoxide	Ta_2O_5		not given			5.9
Titania ..	TiO_2	10.5	5.4	13.5	3.7	2.9
Thoria ..	ThO_2	7.6	5.0	—	0.4	0.2
Cerium Earths	—	7.0	5.5	7.3	4.0	13.3
Lime ..	CaO	14.2	10.9	15.9	16.7	4.1
Alkalis ..	Na_2O	5.0	5.3	3.1	3.4	2.5
Fluoride ..	—	—	3.7	2.9	4.3	—

Pyrochlore is essentially a titano-niobate of lime and rare earth bases together with thorium and alkali fluorides. Cerium is usually the predominant member of the rare earth bases which may be present in amounts ranging from three to as much as 15 per cent. The type formula may be given as $RO.Nb_2O_5(Ti,Th)O_2$, where RO is lime or other oxides replacing lime in part. It should be noted that the figures given in Table I are for concentrates obtained from the beneficiation of low grade ore in which the pyrochlore mineral content may originally be less than 0.5 per cent.

The base gangue constituent of the raw undressed ore may be magnetite and apatite ($3Ca_3P_2O_8.CaF_2$) as in the Sukulu type soils, and silica for Nigerian granite. Milner and Smales (**3**) give a typical composition for Nigerian granite as follows: SiO_2 70, Na_2O 5, K_2O 4.4, Al_2O_3 10.5, Fe_2O_3 3, FeO 6.4, TiO_2 0.2, ZrO_2 0.25, Nb_2O_5 0.2 and Ta_2O_5 0.2 per cent.

The niobite/tantalite series of minerals offer a better source for steelmaking. Typical compositions are shown in Table II. The two minerals niobite and tantalite are isomorphous and form a complete series of which

the type formula may be represented as $(Mn,Fe)O.(Ta,Nb)_2O_5$. The MnO : FeO ratio may vary widely giving rise to mangano or ferro-niobites depending on the relative predominance of the two protoxides.

TABLE II
Niobite Tantalite: Typical Analyses

	Niobium Rich				Tantalum Rich	
	1	2	3	4	5	6
Nb_2O_5 ..	56.4	60.5	67.3	57.0	4.5	29.8
Ta_2O_5 ..	22.8	19.7	7.3	14.7	79.8	53.3
FeO ..	15.8	12.6	11.2	14.5	1.2	6.1
MnO	2.4	7.5	10.3	7.1	13.9	10.4
SnO_2	0.6	0.1	—	—	—	—
ZrO_2	0.3	—	—	—	—	—
TiO_2	—	—	2.90	1.69	—	—
CaO	—	—	0.4	—	0.2	—
MgO	0.4	—	—	—	—	—
WO_3	1.0	—	—	—	—	—
Nb: Ta Ratio Metal ..	2.2/1	2.7/1	8/1	3.3/1	1/20	1/2

With steels the situation facing the analyst is very much simpler even though the addition of niobium is usually made to comparatively complex steels, e.g. to austenitic high chromium nickel steels as a stabiliser against intercrystalline corrosion. The determination of nobium and tantalum in steel, when the two elements are taken together as one element, is a comparatively simple undertaking. The real difficulty arises in making a separate evaluation and because of this it is for the most part avoided in general steel works practice, reliance being placed on a separate determination on the basic ferro-niobium alloy used to make the steel. Tables III and IV show typical steel and ferro-alloy compositions.

TABLE III
Typical Steel Compositions

	FCB per cent	FCB(T) per cent	18/10 Mo/Nb per cent	326 per cent	448 per cent
C	0.08	0.08	0.07	0.25	0.12
Si	0.60	0.60	0.30	0.80	—
Mn	0.80	1.50	1.50	3.00	—
Cr	18.0	17.5	17.5	16.0	10.5
Ni	9.5	12.0	10.5	18.5	—
Mo	—	—	2.75	2.50	0.75
Co	—	—	—	7.00	—
V	—	—	—	—	0.15
Nb	0.90	0.90	0.80	1.75	0.45

TABLE IV
Typical Ferro-Alloy Compositions

	1	2	3
Nb	65.4	53.0	16.9
Ta	7.3	22.8	53.6
Ti	0.50	0.30	0.30
Si	0.68	0.57	0.35
Sn	0.14	0.30	0.29
C	0.05	0.10	0.05
Al	1.60	0.94	2.0
Fe	23.60	15.1	—
Mn	—	7.0	7.5

In considering compounds and reactions which may be of analytical importance the limitations imposed by the inherently weak chemical behaviour of these two elements should at once be recognised. As a consequence of this there may be significant departures from normal or expected behaviour imposed by the presence of other elements. This effect of association, commonly known as 'loss of individuality' is very common in earth acid chemistry. A typical example of this is the loss of specific behaviour imposed by elements such as titanium or zirconium. Titanium alone is completely soluble in acid bisulphate extracts; niobium is completely insoluble. When niobium and titanium are in admixture appreciable titanium is co-precipitated and some niobium is dissolved in the extract. This is merely a single illustration of a general principle which seriously complicates analytical work with titanium-niobium compounds.

Tantalum-Niobium Solutions

Tantalum-niobium solutions are characterised by their extreme proneness to hydrolytic decomposition to insoluble hydrated earth acids. They are obtained by acidification of alkali niobate or tantalate or even by boiling the acidified tartrate solution. This property of easy hydrolytic precipitation is utilised in the preliminary separation from steel solutions.

The pentoxides themselves are stable forms with similar characteristics, Ta_2O_5 being a little more refractory and insoluble than Nb_2O_5. Unlike tantalum, niobium forms a series of unstable lower oxides, e.g. by dry reduction with hydrogen at 1000/1100°C it is reduced to a black oxide approaching, but not quite reaching, Nb_2O_3. Reduction in solution to derivatives of the lower oxides can be achieved with nascent hydrogen and this forms the basis of Cunningham's (4) method for individual evaluation of niobium.

The pentoxides are soluble in hydrofluoric acid, forming fluorides from which insoluble potassium fluotantalate can be precipitated. This is the basis of Marignac's classical separation, which incidentally is still used in metallurgical extraction from the ore, but has now fallen into general disuse as an analytical separation.

Fusion with potassium carbonate yields completely soluble potassium salts $4K_2O.3Ta_2O_5\ 16\ H_2O$, whilst the correspond-

ing sodium salts from fusion with sodium carbonate are almost completely insoluble. The sodium salts may also be precipitated by treating the soluble potash extracts with sodium chloride—this is used as a separation from tungsten. Magnesium salts are quantitatively precipitated by adding magnesium sulphate to the potassium carbonate extracts.

Fusion with potassium bisulphate followed by aqueous or acid extraction results in hydrolytic decomposition and more or less complete precipitation of the hydrated oxides.

Completely soluble extracts of bisulphate melts are obtained with tartaric acid, ammonium tartrate, ammonium oxalate and these solutions of the tartaro and oxalo earth acid complexes form the basis for application of the tannin and cupferron precipitation procedures. Bisulphate melts are also soluble in sulphuric acid and hydrogen peroxide, forming soluble colourless peracid complexes. Titanium may be determined by the hydrogen-peroxide reaction without interference from niobium or tantalum both of which are held in solution by the peroxide.

The Tartaro Complexes

The tartaro complexes may be decomposed by boiling with mineral acid, resulting in hydrolysis and almost quantitative precipitation as hydrated earth acids. Hydrolysis from tartaric solution is used extensively in mineral analysis and also as a separation from titania which is stable in the acid tartrate solution.

The oxalo earth complexes are more stable than the corresponding tartaro complexes. Dissociation by mineral acids gives a very incomplete yield of hydrolysis product, but they are used in preference to the tartaro solutions as the basis for tannin precipitations in which advantage is taken of the differential instability of the respective oxalo complexes to effect a separation of tantalum from niobium.

The tannin precipitates are adsorption complexes produced by reciprocal flocculation of the negative tannin, and the positive earth acid soils. They are obtained as voluminous flocculated precipitates when neutralised hot solutions of the tartaro or oxalo acids are treated with ammonium chloride and excess of tannin solution. The tantalum complex, pale yellow, is precipitated at a higher acid concentration than the orange red niobium complex. In oxalate solutions the interval is sufficiently marked to permit quantitative separation of the two elements, but a clear cut separation in one operation is impossible as the reactions overlap, and a process of repeated fractional precipitation must be adopted, the tantalum rich fractions being re-treated for recovery of co-precipitated niobium. More than anything else the necessity for this fractional treatment of precipitates has militated against the full acceptance and general use of the tannin method, which is otherwise both accurate and elegant.

Precipitation as cupferron complexes is useful in both steel and ferro-alloy analysis. Precipitation is quantitative but unlike tannin it does not permit a separate determination of the two elements, both of which are precipitated together. Precipitation is made from mineral acid solution (5—20 per cent sulphuric or hydrochloric) containing the earth acids as tartaro-complexes. Further separations are necessary as iron, titanium, zirconium and several other elements are co-precipitated, but iron can be removed independently as ferrous sulphide from ammoniacal tartrate solutions. Cupferron precipitation is a useful adjunct to tartaric hydrolysis, most of the earth acids being precipitated by boiling the tartrates with mineral acid, followed by cupferron to recover the last traces.

Colour reactions have received attention in recent years. The reaction with pyrogallol is described by Gots and Kakita (**5**) and more recently by Hunt and Wells (**6**). The tantalum complex is developed in acid solution and the niobium complex in alkaline solution. Both complexes are yellow. Both systems obey Beer's Law, but there is interference from a number of elements, in particular, from titanium.

The thiocyanate reaction offers more promise of successful development. This was first described by Alimarin and Podvalinaya (**7**) and later by Freund and Levitt (**8**) in which the colour system is stabilised by using high concentrations of acid, chloride, thiocyanate and miscible solvent.

There are two principles in general use for the precipitation of niobium and tantalum from ferrous solutions, i.e. steels and ferro-alloys: (a) Hydrolytic precipitation; (b) Cupferron precipitation.

(a) The Hydrolysis Method

Hydrolytic precipitation may be made

from dilute perchloric, sulphuric, or hydrochloric acid solutions in a similar manner to the well known method for tungsten. The hydrolysis is much more certain than the corresponding tungstic acid hydrolysis, and precipitation aids such as cinchonine, etc., are considered unnecessary. None the less the completeness of separation has been questioned by Cunningham and others. Weiss and Landecker (**9**) stated that hydrolytic precipitation is complete from perchloric acid solution and Silverman (**10**) used this principle in one of the earliest methods for steel. Cunningham (**4**) stated that Silverman's perchloric acid method gave incomplete recovery, particularly if much titanium was present (presumably another example of modified individuality), and the niobium hydrolysis product was also said to be grossly contaminated with titanium.

Our previous experience (**11**) of hydrolysis from dilute hydrochloric or sulphuric acid solution had indicated a tendency for a small amount (usually less than 1 mg.) of niobium to escape precipitation and recourse has been made to various recovery treatment, e.g.:

1. Treatment of the filtrate with cupferron.
2. Conducting a rapid stream of hydrogen sulphide through the hot dilute filtrate.
3. The use of an additional collecting agent such as Cinchonine or Rhodamine B.
4. Boiling the filtrate after the addition of sulphurous acid.

Application of either 1 or 2 leads to unnecessary contamination, due mainly to iron in the first case and to sulphides of molybdenum, copper and tin in the second. The use of either Cinchonine or Rhodamine B must be preceded by reduction with sulphurous acid if contamination with iron is to be reduced to a minimum. After such reduction the addition of these reagents then becomes unnecessary. The sulphurous acid modification yields a residue particularly free from iron and by using a large excess in the initial hydrolysis complete recovery of niobium is made in a single operation with a minimum of contamination. There is substantial hydrolysis of titanium under these conditions but this does not affect the completeness of the precipitation of niobium.

The results on three rustless high niobium steels (Table V) indicate the completeness of precipitation by sulphurous acid hydrolysis.

TABLE V
Efficiency of Sulphurous Acid Hydrolysis

	Steel 1	2	3
	per cent	per cent	per cent
Niobium found ..	4.22	4.95	4.96
Recovered from filtrate by means of cupferron	Nil	Nil	Nil

The initial residue may be taken to contain all the niobium and tantalum and almost all of the silicon. Tungsten will be precipitated quantitatively if Rhodamine B has been added. Titanium, molybdenum (if a large amount of this metal is initially present) and small amounts of iron and chromium oxides will also be present. Silica is removed by treatment with hydrofluoric and sulphuric acids.

Fusion of the residue with potassium carbonate gives a clean aqueous extraction of niobic, tantalic, tungstic, and molybdic oxides. If the residue contains less than 5 mg. of iron the loss of the former elements on aqueous extraction is negligible. With greater amounts than this, it is advisable to make a second carbonate fusion of the iron precipitate. Small amounts of iron in the aqueous fusion extract do not readily coagulate and may pass the filter if coagulation is not assisted by digestion.

In applying Powell, Schoeller and Jahns (**12**) magnesia separation to the fusion extract there appeared to be a distinct tendency for niobium to be lost in the washing. The order of error introduced in this way is shown by Table VI which refers to determinations on synthetic solutions prepared from known amounts of the pure oxides. In both cases, the oxides were fused with potassium carbonate, aliquot portions of the extracts combined and the niobium determined by the magnesia procedure.

TABLE VI
Loss of Niobium in Magnesia Separation

Nb_2O_5		WO_3		Total Oxides	
g.		g.		g.	
Added	Found	Added	Found	Added	Found
0.0585	0.0532	0.0600	0.0653	0.1185	0.1185
0.0585	0.0535	0.0600	0.0647	0.1185	0.1182

From these values, it is clear that while the total recovery is correct, there are errors in separation causing niobium values to be consistently low and tungsten correspondingly high. This indicated either that niobium precipitation was incomplete or else the precipitate was becoming peptised during washing. From the appearance of the filtrates (often cloudy) the latter seemed more probable.

The next step was to try a wash liquor containing both ammonium chloride and potassium carbonate and representing more nearly the composition of the solution from which precipitation was made. Subsequent results showed little improvement; the tendency for niobium to wash through the filter was still evident. Finally, a wash solution was prepared containing ammonia, ammonium chloride, potassium carbonate and magnesium sulphate in such proportions as to be almost identical to the precipitation solution. Solubility of niobium in this modified wash liquor was greatly reduced and the presence of divalent magnesium and sulphate ions appeared to be beneficial in preventing peptisation of colloidal precipitates. The results of typical separations using this modified wash liquor are shown in Table VII.

TABLE VII

Efficiency of Niobium—Tungsten Separation Modified Magnesia Conditions

Nb_2O_5 g.		WO_3 g.		Total Oxides g.	
Added	Found	Added	Found	Added	Found
0.0562	0.0566	0.0603	0.0600	0.1165	0.1166
0.0562	0.0564	0.0603	0.0603	0.1165	0.1167

These separations are much sharper. Further trials were made on steel, using 5 g. of a normal 18 Cr/8 Ni steel (W and Nb free) to which known amounts of niobic and tungstic oxides were added in the form of solutions as before. The results obtained are shown in Table VIII below.

These results show close recoveries of both oxides. The tendency to be slightly high in one or two cases is perhaps due to contamination of the final residue with a trace of ferric oxide. If the greatest accuracy is required it would be comparatively simple to determine this and make the necessary correction.

The magnesia process serves to separate niobium and tantalum from tungsten and molybdenum, but there is no separation from titanium; this element, if present, is co-precipitated with niobium and tantalum and must be corrected for in the final residue. Most niobium steels contain only incidental trace amounts of titanium and correction can be made applying the hydrogen peroxide reaction after fusing the residue with potassium bisulphate and extracting in acid tartrate or oxalate solution. If larger amounts of titanium are present it is better to make a separation. This may be done by the bisulphate-tannin method in which the bisulphate melt of the mixed oxides is extracted in five per cent sulphuric acid containing tannin. Niobium and tantalum are precipitated quantitatively as tannin complexes. Titanium and zirconium remain in solution.

Another separation from titanium suitable for larger amounts of niobium and tantalum is the oxalate-salicylate method in which the oxalates are decomposed by the addition of calcium chloride and a combined precipitate of the earth acid salicylate complexes and calcium oxalate is obtained. The titanium salicylate complex is soluble but a little earth acid remains with it. This is recovered by precipitating the titania fraction with tannin and ammonium acetate and recovering the residual earth acid from it by the previously mentioned bisulphate-tannin precipitation in dilute sulphuric acid.

Typical results by the sulphurous acid hydrolysis method with magnesia separation of tungsten are given in Table IX over the page.

(*b*) *The Cupferron Method*

Cunningham's cupferron method may be applied directly to steel solutions but it is really more valuable for the steelmaking ferro-alloys containing 50 per cent or more of niobium. For steels it compares unfavourably with the hydrolysis method in that appreciable iron is co-precipitated with the

TABLE VIII

Efficiency of Niobium—Tungsten Separation Modified Magnesia Conditions

	Nb_2O_5 g.		per cent Nb equiv. on 5 g.		WO_3 g.		per cent W equiv. on 5 g.	
	Added	Found	Added	Found	Added	Found*	Added	Found
1	0.0297	0.0299	0.42	0.42	0.0591	0.0592	0.94	0.94
2	0.0297	0.0318	0.42	0.44	0.0591	0.0587	0.94	0.93
3	0.0594	0.0606	0.83	0.85	0.0591	0.0596	0.94	0.94
4	0.0594	0.0608	0.83	0.85	4.0591	0.0581	0.94	0.92
5	0.1188	0.1185	1.66	1.66	0.0591	0.0617	0.94	0.98
6	0.1188	0.1202	1.66	1.69	0.0591	0.0598	0.94	0.95
7	Blank	(0.0010)	—	—	Blank	(0.0005)	—	—
8	Blank	(0.0011)	—	—	Blank	(0.0006)	—	—

* Blank deducted.

TABLE IX

Niobium in Steel: Typical Results
H_2SO_3 Hydrolysis MgO Separation Method

Analyst	1 18Cr 8Ni	2 18Cr 8Ni 3Mo 1Nb	3 13Cr 13Ni 1Mo 10Co 2W 3Nb	4 Alcomax Magnet 18Ni 3Cu 12Co 9Al 1Nb
	per cent	per cent	per cent	per cent
1	0.29	1.06	3.03	1.13
2	0.29	1.02	3.00	1.14
3	0.28	1.01	3.00	1.13
4	0.28	1.02	3.02	1.12
5	0.29	1.02	3.05	1.14
6	0.27	1.01	3.03	1.13
7	0.29	1.01	3.01	1.16
8	0.29	1.04	3.04	1.12

cupferron complex. Titanium is also quantitatively precipitated, but it is claimed that if hydrofluoric acid is present tungsten remains fixed in solution and does not interfere.

As considerable iron is co-precipitated, the usual finishing procedure is to ignite the cupferron complexes to oxide, fuse with bisulphate, extract in tartrate, and remove iron as ferrous sulphide from ammoniacal tartrate solutions. The niobium, tantalum, and titanium are then recovered as pure oxides by a further cupferron precipitation. The usual separations or corrections for titanium must be applied.

A comparison of results by the method and by the sulphurous acid hydrolysis method are shown in Table X.

TABLE X

Niobium in Steel
Comparison of H_2SO_3 and Cupferron Methods

Analyst	18Cr 10Ni 1Nb		18Cr 8Ni 1Nb	
	H_2SO_3	Cupferron	H_2SO_3	Cupferron
	per cent	per cent	per cent	per cent
1	0.93	0.91	0.97	0.97
2	0.95	0.93	0.99	—
3	0.95	0.94	1.00	1.00
4	0.95	0.96	0.97	0.96
5	0.94	0.93	0.99	0.94
6	0.93	0.95	0.98	0.98

Basically the same method can be applied to the high niobium ferro-alloys except that the initial decomposition of the alloy must be made with mixed hydrofluoric and nitric acids and the fluorides expelled as boron trifluoride after mixing the earth acids with tartrate.

(To be continued)

REFERENCES

(1) Schoeller, W. R., 'The Analytical Chemistry of Tantalum and Niobium,' Chapman and Hall, 1937.
(2) Schoeller, W. R., and Powell, A. R., 'The Analysis of Minerals and Ores of the Rarer Elements,' Griffin, 1940.
(3) Milner, G. C. W. and Smales, A. A., *Analyst*, 1954, **79**, 315.
(4) Cunningham, T. A., *Ind. Eng. Chem.*, Anal. Ed., 1938, **10**, 233.
(5) Gots, H., and Kakita, Y., *Sci. Repts., Research Inst. Tohoku University*, Series A, 1950, **2**, 249.
(6) Hunt, E. C., and Wells, R. A., *Analyst*, 1954, **79**, 345.
(7) Alimarin, I. P., and Podvalnaya, R. L., *Zhur. Anal. Khim.*, 1946, **1**, 30-46 ; *Chem. Abs.*, 1949, **43**, 2543.
(8) Freund, H., and Levitt, A. E., *Anal. Chem.*, 1951, **23**, 1813.
(9) Weiss and Landecker, *Chem. News*, 1910, **101**, 2, 13, 25.
(10) Silverman, L., *Ind. Eng. Chem.*, Anal. Ed., 1934, **6**, 287.
(11) Bagshawe, B., and Elwell, W. T., *J. Soc. Chem. Ind.*, 1947, **66**, No. 11, 398.
(12) Powell, A. R., Schoeller, W. R., and Jahn, C., *Analyst*, 1935, **60**, 506.

Control of Temperature

CONSTANT temperature control is the feature of two new instruments introduced by Techne of Duxford, Cambridge.

The 'Tempunit' is a self contained constant temperature control unit with a pneumatic control system which is claimed to have all the sensitivity of electrical contact methods with far greater dependability and longevity. It can be used to control a three gallon bath or to circulate water to external instruments such as refratometers and viscometers. The heater coil is of 1,000 watts power, sufficient to give rapid heating from room temperature. The temperature range is 10 to 96° C.

The thermostatically controlled water bath also incorporates pneumatic control. This is in preference to fragile glass components such as mercury toluene regulators and mercury contact thermometers. It is claimed that the temperature can be maintained to within ± 0.015° C at 35° C. When operating above about 60° C it is recommended that a few chips of paraffin wax be added to the bath to prevent evaporation.

Colloidal Silica Millions Aid Housewives

A chemical which keeps rugs and carpets, fabrics, painted walls, paper, and other surfaces clean and fresh-looking has been developed by the Du Pont Company. Called Ludox, the chemical is a colloidal silica, consisting of millions of particles of silica. It does its work by filling up the microscopic pits and crevices, known as soil receptor sites that all surfaces possess in varying degrees. Particles of dirt become embedded in these sites, which makes them difficult or impossible to remove by ordinary methods. When Ludox is used to fill the soil receptor sites, dirt cannot penetrate.

Notes on Microtechnique for the Industrial Chemist

by S. M. CHARLETT, F.R.M.S.

THE term microtechnique always seems to conjure up visions of zoological or botanical laboratories, with microtomes, scalpels and all the paraphernalia of the pathologist or histologist. For some reason very few people, even the workers in industrial laboratories, associate the term with the very considerable amount of microscopical work which is performed in the chemical laboratory. The microscope is a valuable tool in both routine control work, and in research, and the chemist has need to be familiar with certain techniques of microscopical preparation and observation.

Much has been written about the microscopical appearance and characteristics of many such materials, and it is not the intention to repeat such observations here, but little seems to have been written concerning the best methods of preparing material for observation in order to make it possible to observe such characteristics, and the writer would like to put forward some techniques which have been used in his laboratory with satisfactory results.

Accessories

Before proceeding to consider the actual techniques employed, it may be of interest to remark upon the few accessories which may be required, in addition to the microscope. As to the microscope itself, the worker is advised to consult a firm of reputable manufacturers, state the requirements of the instrument needed, and give consideration to their suggestions.

Microscope slides, those at least which the industrial microscopist will use, are strips of thin glass, 3 inches long by 1 inch broad. They are available in a variety of thicknesses, but the writer would recommend the use of those which are 1-1.2 mm thick as a satisfactory general purpose slide. They will stand a considerable amount of handling, whereas the thinner slides will easily break.

Cover glasses are thin discs or squares of glass which are used to cover specimen placed on the slides. They protect the specimen, reduce the evaporation of liquids in which the specimen may be immersed for examination, and prevent the ingress of dust or dirt which may hinder observation. These too may be obtained in a number of thicknesses, and again it is suggested that a cover glass thickness of code number 2 is used. These are thick enough to afford adequate protection of the specimen, and thin enough to allow close observation, whilst being quite robust and capable of enduring normal handling. It is advisable to use the circular cover glass for a reason which will become obvious later.

In addition to these basic requirements, there are a small number of additional accessories which will greatly facilitate the preparation of materials for examination.

Microslide Cells: It is frequently necessary to examine specimens which are rather thicker than usual, large crystals, etc., and if these are merely covered with a cover glass they will tilt it and make observation almost impossible. To meet this eventuality the microscopist makes use of a simple piece of equipment known as a cell. This consists of an annular ring of glass or aluminium, purchased from any microscope supplier, sealed to the centre of a microscope slide with shellac, gold size, or other cement. The thick specimen is placed in the cell, covered with a cover glass, and examined as required.

Ringing Turntable: This is a refinement rather than a necessity, but is of value when it is necessary to seal cover slips to slides, or over a cell. The turntable simply consists of a disc of heavy metal mounted on a bearing which allows it to rotate freely in the horizontal position. The disc is fitted with two clips which hold slides in place, and the centre generally carries a series of concentric rings etched in the surface. These enable a slide to be oriented so that the cover glass coincides with a ring thus allowing the cover glass to rotate concentrically, and not eccentrically.

In addition to the disc, the turntable has a rest for the hand of the operator, and the

apparatus is used by clipping a slide on to the table, ensuring that the cover glass is concentric with the circles, and the table is set in motion by a gentle push, sufficient to give a speed of about 100 revolutions per minute. A camel hair brush is charged with a quantity of the cement used to seal the cells described earlier. This should then be touched gently to the edge of the rotating cover glass, using the rest to steady the hand of the operator if necessary, when an even ring of the cement will be deposited so as to effectively seal the cover glass in place.

A few small instruments are needed in addition to the above, a pair of histological needles, two or three small brushes known as camel hair brushes, forceps, a small spatula and a variety of slide labels.

With the above equipment on hand the microscopist may proceed to the preparation of specimens for examination, or to use the correct term he may proceed to the mounting of specimens. Methods of preparation may be divided into two distinct groups, the temporary mounts and the permanent mounts, each of which has its individual reagents and techniques.

TEMPORARY MOUNTS

This type of preparation is generally employed for the routine examination of materials, for the detection of adulteration, and for the microscopical characterisation of newly proposed materials. A number of methods have been used for such preparation, the origins of which are lost in the mists of antiquity, and many different reagents have been employed. Here, however, it is only proposed to outline those methods which have been satisfactorily used in the writer's laboratory and which may be classified under three sub-headings.

Water Mounts: The most widely used method of examining such specimens as pigments, vegetable powders, starches, and other water-insoluble materials, for their general appearance and freedom from adulterants. One of the most important points to be remembered in this technique and all other methods of mounting specimens, is that the mount should not be overcrowded with material, otherwise it will be impossible to distinguish between individual particles when the mount is examined under the microscope. Features which may be essential to the identification of a sample, or to the detection of adulterants, may well be obscured or overlooked.

In view of this it is advisable to adopt a standard technique which will obviate the tendency to use too great a quantity of material for a mount. A small quantity of the sample is well dispersed in about three times its weight of water on a glass plate, using a small spatula. One drop of this suspension is removed to the centre of a clean slide, and there mixed with two drops of water. A clean cover glass is held above the mixture, parallel to the face of the slide, and allowed to drop squarely over it. The preparation may now be examined under the required magnification. Many workers have recommended other methods of placing the cover glass over a preparation, but the writer prefers that described above as it avoids the clumping of particles by capillary attraction, which usually takes place when the standard method is employed.

Non-Water Mounts: These are usually employed in the case of materials which would be adversely affected by treatment with water, either by solution, or by the production of other effects which would mask the true structure. The mounting agents usually employed for this type of mount are liquid paraffin, glycerine, castor oil, or one of the widely used histological agents, xylene or benzene. The use of the latter two reagents entails ensuring that the sample is free from any uncombined water, as the presence of such will produce cloudiness in the mount, and this is generally done by drying the material at as high a temperature as possible, without causing undesirable effects such as crumbling, for about thirty minutes.

Where for some reason the use of heat to dry a specimen is inadvisable the writer would recommend the use of benzyl alcohol, a reagent of high enough refractive index to permit good structural differentiation, and which is not affected by the presence of up to approximately 5 per cent water in the material to be mounted. With the reagents mentioned in this section, the technique described under the previous heading should be employed when mounting, the preliminary dilution being performed in a quantity of the mounting agent, and one drop of this being used for the final mount.

Numerous other reagents have been recommended for the preparation of temporary mounts, by various workers, the suggestions being based on the refractive indices of the agents recommended. For many microscopical examinations it is of great value to have as large a difference as possible between

the refractive index of the specimen being examined, and that of the mounting agent employed in the preparation, such a condition being favourable to the differentiation of various structures, which may otherwise remain unobserved. A brief list of the refractive indices of some of the reagents which have been suggested as possible mountants is included in this article, in the hope that it may prove of some interest to those who wish to experiment for themselves.

Dry Mounts: Under certain circumstances it may be impossible to use a mounting agent for the preparation of microscopical mounts. In such cases a dry mount may be prepared, although this is not usually as satisfactory as a liquid mount, except in one or two cases, an instance of which will be given later in this article.

A temporary dry mount is quite simply prepared. If the powder or crystals are comparatively fine, a little may be dispersed on the centre of a clean slide, covered with a clean cover glass, and examined with the required magnification of the microscope. If the specimens are rather thick, the mount should be prepared with the aid of a cell, prepared as described earlier. A very small quantity of the material is introduced into a cell, ensuring that it is evenly distributed, and a cover glass is placed on. The preparation may then be examined at leisure.

Special Temporary Mounting Agents: In the above paragraphs the more general temporary mounting agents have been considered, but in addition to these there are innumerable suggestions for the mounting of specific materials. There is not room here to discuss many of these, but the writer would like to note a few of them.

Preston (**1**) described a medium for the mounting of specimens of cellulose, either as temporary or permanent preparations. This consisted of cellulose nitrate 25 per cent, triacetin 25 per cent, and methyl ethyl ketone 50 per cent. The refractive index is 1.42 as compared with that of cellulose which is about 1.52-1.54. As a consequence there is quite good structural differentiation.

Marshall (**2**) devised a medium with the very high refractive index of 1.84. This consisted of methyl iodide saturated with sulphur and arsenious sulphide, and preparations had to be sealed in order to prevent evaporation of the mountant. The high refractive index ensures contrast for the majority of subjects likely to be mounted in this material.

The writer (**3**) formulated a simple agent for the temporary mounting of vegetable powders. Essentially this consisted of 15 parts phenol, 15 parts lactic acid, 35 parts glycerine, and 25 parts distilled water. This is used to prepare temporary mounts in much the same way as other mountants, with one difference. A small quantity of the material is diluted with three times its weight of mountant, as described earlier, and one drop is transferred to the centre of a clean slide. Two drops of the mountant are added, a cover glass placed over the mount, and the slide put aside in a warm place for about ten minutes.

Subsequent examination of the preparation will reveal very good structural differentiation and definition. This is due to the action of the reagent in rendering the specimen more transparent, an action known to microscopists as clearing, and to the comparatively high refractive index which produces greater contrast of structures and medium. The action of clearing is possessed by a number of other reagents, but there are few other combined clearing and mounting agents.

PERMANENT MOUNTS

The making of permanent microscopical preparations has several objects in view. Firstly, all laboratories should maintain a file of standard quality materials, whether raw or finished products, in order to make comparison between further samples of such materials. If, every time one wishes to make such a comparison, it is necessary to make two preparations, one of the standard and one of the material under test, then time is wasted. If, on the other hand a reference permanent slide is kept, comparison is easily made, and little time is wasted. Such a reference slide is invaluable in plant control where possibly dozens of samples are examined in a day, and the constant duplication of preparations would involve considerable time waste.

Secondly, all laboratories have their complement of junior staff, inexperienced, and eager to learn if provided with the right incentive. A file of reference slides is sufficient incentive to such personnel to study the microscopical appearances of various products, and raw materials, in any spare moment, without having to waste time making the preparation. In addition it is much simpler to show a slide to a junior

and to explain the structures observed, than to try and explain in any number of words or sketches.

Finally, it is in the interest of all workers to record any unusual or otherwise interesting observations or material. Photography may be employed for this purpose, but it is an expensive method of doing so, and demands a fair amount of experience and technique, which all workers may not have the opportunity to acquire. The permanent microscopical slide preparation on the other hand is very cheap to prepare, needs no special very expensive equipment, and in the writer's opinion the technique required would be at the command of all laboratory workers, and whilst an organisation may be willing to employ a photographical specialist, they are not willing to do the same in respect of a micro-technician. In addition the time factor is important, the camera is not always available, and a dozen permanent preparations may be made in the time taken to record and develop one photograph.

Numerous methods have been put forward by many workers for the permanent mounting of specimens of powders and pigments. Earlier workers used the well tried histological mounting agents such as glycerine jelly, or Canada balsam. These all revealed disadvantages, either they dried out, or turned yellow with age. Canada balsam had the added disadvantage of becoming acid with age, and numerous specimens were ruined by this reaction. It was natural under such circumstances for workers to look elsewhere for their mountants. Those referred to here have all been well tried in the writer's laboratory, and have proved satisfactory under prolonged storage, and light exposure.

New Mountants

Allen (**4**) was among the first to deviate from standard methods, and he suggested the use of the American household cement known as Ducol, as a mounting agent. This has been found to have satisfactory characteristics of refractive index and durability, and can be recommended, although it is not easily obtainable in this country.

Miller (**5**) devised two media for the express purpose of examining pigments and paper fillers. For robust specimens he used a mounting agent containing 82 parts amyl acetate, six parts ether, four parts absolute alcohol, and 1.9 parts of purified flake pyroxylin. For more delicate material the formula was modified to become 80 parts of amyl acetate, four parts ether, six parts absolute alcohol, two parts butyl alcohol, and 1.9 parts flake pyroxylin. The method of using these agents is different from that employed with the normal mounting media, and a certain amount of practice is necessary to enable the worker to become adept. A quantity of the specimen is dried at 105°C for one hour. If this is impracticable then the sample is dried at as high a temperature as possible, without producing any unwanted effects on the material. A speck of the dried material is well dispersed in three times its weight of mountant, and a drop of the mixture transferred to a clean microscope slide. Two drops of the mountant are added and the two well mixed with a small spatula.

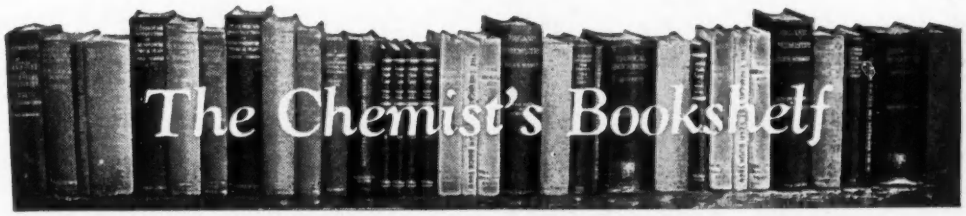
Well Dispersed

When the specimen has been well dispersed, a drop of distilled water is placed on the slide, which is then tilted slightly so that the water runs into the mixture, which immediately forms a surface film. Most of the water is then removed with a piece of filter paper, and the remainder is allowed to evaporate, or the slide may be placed in the 37°C incubator to dry, when it will be found that the suspension has formed an even film of well distributed particles. The film may now be permanently preserved by adding two drops of Clarite in xylene, and covering with a cover glass. Clarite is a mountant of American origin, but may be obtained in this country.

The writer (**6**) utilised the modelling cement Durofix for mounting starches and (**7**) for mounting milk powders as permanent standards. This was found to have a high refractive index, and the hilum on starch granules could be plainly seen. The technique is quite simple. A small amount of the sample is placed on a clean microscope slide, well mixed with an equal amount of Durofix, and the mixture is then spread over the surface of the slide and allowed to dry. A small portion of the dried mixture is then removed to a clean slide and there dispersed in four times its volume of fresh Durofix. A clean cover glass is added, taking care to avoid the inclusion of air bubbles, and the slide put aside to dry.

Examination of the hardened preparation will reveal the particles well dispersed in the

[*continued on page 1488*



ELECTROMETRIC *p*H DETERMINATION: THEORY AND PRACTICE. By R. G. Bates. John Wiley & Sons, New York; Chapman & Hall Ltd., London. 1954. Pp. xiii + 331. 60s.

The determination of *p*H must be one of the commonest operations in chemistry and it is all too often carried out, even in other than routine determinations, with little or no understanding of the principles used to determine it or of the real meaning of the value once determined.

This book aims at counteracting both of these slipshod attitudes, and Dr. Bates, whose work at the National Bureau of Standards is well known, is obviously well-qualified to write it. The first six chapters of the book are given over to a discussion of scales of *p*H from a theoretical point of view—their meaning, usefulness, and their validity, both in aqueous and in non-aqueous media. There is a full consideration of the transition from rigorous theory to empiricism. Emphasis is laid on the necessity for accurate and reliable standards. The practical implications of all these factors are also fully covered.

The remaining four chapters of the book are concerned with the experimental determination of *p*H by electrometric methods. All aspects of this, such as the preparation of electrodes, the design of the actual measuring apparatus and the devising of automatic control methods (to mention but a few) are clearly presented and fully documented. The book is copiously illustrated with clear and carefully chosen diagrams.

If the only result of the publication of this book were to draw attention to the lack of thought from which *p*H determination so often suffers, it would be valuable. That it also makes it possible to correct this attitude and to make the determination a reliable one with a generally accepted meaning makes the book an essential part of the equipment of any laboratory concerned with the measurement of 'acidity' or 'alkalinity.'

—CECIL L. WILSON.

THE CHEMISTRY OF PETROLEUM HYDROCARBONS. Part I. Edited by B. T. Brooks, C. E. Boord, S. S. Kurtz, Jr. and L. Schmerling. Rheinhold Publishing Corp., New York; Chapman & Hall Ltd., London. 1954. Pp. 664. 144s.

The first volume of this series contains 21 chapters dealing with various aspects of the chemistry of petroleum. The chapter titles and their authors are given in order to indicate the scope of this book.

1. Hydrocarbons in Natural Gases; D. T. McRoberts & T. W. Legatski.
2. Hydrocarbons in Gasolines, Kerosines, Gas Oil & Lubricating Oils; A. N. Sachanen.
3. Composition of Petroleum Waxes; B. T. Brooks.
4. Types of Crude Petroleum; W. A. Gruse.
5. The Composition of Shale Oils; H. N. Thorne and J. S. Ball.
6. Origin of Petroleums; B. T. Brooks.
7. Extractive & Azeotropic Distillations; C. S. Carlson.
8. Separation of Aromatics by Selective Absorption; A. E. Hirschler.
9. Principles of Solvent Extraction; A. W. Francis & W. H. King.
10. Separation of Paraffins by Urea & Thiourea; R. L. McLaughlin.
11. Physical Properties and Hydrocarbon Structure; S. S. Kurtz, Jr.
12. Ultra-Violet Spectra of Hydrocarbons; W. Priestley & B. F. Dudenbostle.
13. Molecular Structure and Spectroscopic Data; E. G. Rosenbaum.
14. Analytical Application of Infra-red and Raman Spectroscopy; H. E. Tenney.
15. Mass Spectroscopy of Hydrocarbons; W. S. Young.
16. Analysis and Composition of the Heavier Petroleum Fractions; K. Van Ness.
17. Preparation of Pure Paraffins and Olefines; B. T. Brooks.

The Chemist's Bookshelf

18. Synthesis of Low Molecular Weight Alicylic Hydrocarbons; J. M. Derfer.
19. Synthesis of Low Molecular Weight Aromatic Hydrocarbons; J. M. Derfer.
20. Synthesis of High Molecular Weight Hydrocarbons; W. M. Schissler and L. McLaughlin.
21. The Fischer-Tropsch Process; H. H. Storch.

It will be obvious from the above list of contents that much of the subject matter of this book has been dealt with in recent books by Rossini, Van Ness, Farkas, Brooks, Treybal, etc. This the editors realise and state that it was considered advisable and opportune to bring together for review in one treatise the chemistry of hydrocarbons as we now know it. The first volume therefore deals with the occurrence of petroleum hydrocarbons (Chapter 1-6) the separation of hydrocarbons (Chapters 7-10), the physical properties and analysis by physical chemical methods (Chapters 11-16), and the synthesis of hydrocarbons (Chapters 17-21). Presumably future volumes will deal with what might be termed the primary reactions of hydrocarbons, namely oxidation, pyrolysis, nitration, sulphonation, etc., subjects on which the existing monographs are now out of date. If the future volumes of this series are produced with the same care as the present book the series will be well worth while and a valuable addition to the literature on this fascinating subject.

With so many chapters by different authors it is difficult to single out any particular chapter for special mention. The chapter on the separation of paraffins by urea and thiourea contains a welcome discussion on the theoretical aspects of adduct formation, although the term 'adductionation' seems an unfortunate choice for separations performed by this means. S. S. Kurtz, Jr., makes full use of the API data on hydrocarbons in an excellent discussion on the relationship between physical properties and hydrocarbon structures while the chapters by W. A. Gruse (Types of Crude Petroleum) and J. M. Derfer (Synthesis of Low Molecular Weight Alicylic and Aromatic Hydrocarbons) are equally excellent. The chapter on the Origin of Petroleum emphasises the current views of American chemists on this complex subject, but neglects the contributions of European geologists (Kreici Graf, Hlouschek, Illing). For this reason it lacks the completeness which might be expected in a work of this nature.

The book is well produced on good paper and adequately indexed. The price, however, places it out of the reach of students and laboratory workers. The completed work, however, will ultimately replace 'Ellis' as a reference text and be welcomed by research workers in the field of hydrocarbon chemistry.—F. MORTON.

DETERIORATION OF MATERIALS: CAUSES & PREVENTATIVE TECHNIQUES. Edited by G. A. Greathouse & C. J. Wessel. Reinhold Publishing Corporation, New York; Chapman & Hall, London. 1954. Pp. xvii + 835. 96s.

The total amount of materials and effort which is annually brought to waste by the natural processes of deterioration will never be known, even approximately. The foreword to this book suggests a figure of $12,000,000 worth annually as a conservative estimate. The problem attracts special interest in war, and it is upon the work of an American war-time panel of experts that the present book is founded. Over 20 authors have contributed special sections, yet there is no evidence of uneven style throughout the volume, and the indexing is uniformly good.

The book is especially useful because of the embracing treatment afforded to the causes and prevention of deterioration. Thus not only destruction due to electrochemical processes is dealt with, but that caused by insects and moulds is also considered. Again, the importance of climate, storage methods and packaging techniques are likewise shown to be as important as the more precisely stated variable of temperature or *p*H. Also, the decay properties of metals and alloys which are so widely described elsewhere are combined with discussions of the problems attending the use of plastics, textiles or wood.

In short, this volume provides a valuable example of the application of science to a practical and enormously important problem. Lastly, the treatment of preventative methods does not deserve least mention, for the whole aim of the war-time committee, of of the book, is to suggest practical means for avoiding and excluding wastage by deterioration.—T. K. ROSS.

Company Meeting

Imperial Chemical Industries

Record Group Sales

Dr. Alexander Fleck's Speech

THE 28th annual general meeting of Imperial Chemical Industries, Ltd., was held on June 16 in London.

Dr. Alexander Fleck, the chairman, in the course of his speech, said :—'The consolidated sales of the Group, after deducting the value of the sales made by our new subsidiaries, have increased from £282 millions to £327 millions—an increase of £45 millions, or 16 per cent over the figure for 1953, itself at that time the highest in our history. The Company's home sales and direct exports each increased by approximately the same percentage.

'I should like most specially to draw your attention to the table of price indices in which the changes in home trade prices of the Company's products are compared with other significant indices. I am sure you will agree that the comparison shows the Company's prices in a very favourable light. Since 1938 the cost of our raw materials has risen by 272 per cent and the earnings of our workers have risen by 202 per cent. For the same period the Board of Trade wholesale price index increased by 225 per cent. In comparison with these increases (each of which exceeds 200 per cent) the prices at which ICI sells its products in the home market have risen by only 91 per cent. This, I think, you will also agree, shows the remarkable success which has attended the Company's policy of keeping its selling prices as low and as stable as possible. Low and stable prices encourage our customers to use more of our products, and as our products are used by many British industries, we believe that our price policy aids and supports the economy of the country as a whole.

'Between 1953 and 1954 the Company's price index for home sales has moved up by one point only, and the increase in the value of our home sales during this period is therefore almost entirely due to increase in volume. The consequential increase in profit for 1954 is also attributable to increase in volume, coupled with improvements in efficiency due to Work Study and other factors.

'The Company will continue this price policy and will aim not only at absorbing increased costs but, wherever practicable, at seeing that reductions in costs resulting from improved methods and greater efficiency are reflected in lower prices to its customers. Let me emphasise, however, that the price indices I have quoted are averages, and that it may not be possible in all cases to avoid an increase in price ; in fact, I am sure that some readjustments upwards in some of our products will almost be inevitable. This is particularly so where raw materials, fuel and freight represent a large proportion of total costs. We are glad to play our part with others, first of all in striving after methods of increasing productivity, and then of passing on the results of such efforts. Contributions of this nature will, we hope, come from all branches of British industry. It is by such contributions, widespread as they should be, that each one of us must earnestly hope that effective action will soon be taken to prevent the inflation which is threatening to erode our material standards.

'As regards current trading, I am pleased to tell you that in 1955 we have so far experienced a period of great activity. The general level of both home and export sales is well above that of the corresponding period of last year.'

The report was adopted.

• HOME •

I.C.I. Long Service Awards

Of 47 employees of I.C.I. (Leathercloth Division) Ltd., Hyde, who received awards for long service, five had spent 40 years with the firm, 24 had 30 years' service, and 18 had 20 years' service.

Water Pollution Laboratory

On Monday, Lord Salisbury, Lord President of the Council of the Department of Scientific & Industrial Research, opened the new water pollution research laboratory at Stevenage, Herts. A full report will appear in our next issue.

Uranium Ore Agreement

In a recently concluded US/Belgium agreement, Britain and the US will have options on 90 per cent of the uranium ore produced in the Belgian Congo in 1956-7, and 75 per cent for the following three years. A similar agreement is to be made between Britain and Belgium.

British Patent Trends

Of the record number of 26,629 completed specifications filed at the Patents Office last year, the shortage of assistant examiners has resulted in a concentration of 25,000 still to be examined. The year's files show a marked increased interest in the production of antibiotics, particularly terramycin, aureomycin and tetracycline. Developments in the electrolytic production of titanium, the new 'wonder' light metal, were similar to those taking place in the US.

Search for Natural Gas in Sussex

The Gas Council is to sink a second deep well near Crowborough, Sussex, as part of their five year search for natural gas. The site of the well is about one mile south-east of the first well, and work is likely to begin in the next few weeks and to continue for about four months. The first well which was sunk to a depth of about 4,500 ft. revealed small shows of gas at several levels. The results obtained and subsequent seismic surveys in the area have now been studied by the technicians of the D'Arcy Exploration Company (a member of the BP group) which is undertaking the work for the Gas Council.

Pyrex Products for Copenhagen

James A. Jobling & Co. Ltd., of Sunderland, manufacturers of Pyrex, will show a full range of their latest designs in Pyrex Brand heat-resisting oven-to-table glassware (both clear and coloured) at the Copenhagen Fair. They will also show a representative range of their laboratory and scientific glassware.

Britain to Help Danes

Britain and Denmark have agreed to collaborate in a joint programme of research and development in the unclassified field of peaceful applications of atomic energy. Under the agreement Britain will assist Denmark in the design and construction of a high-flux research reactor of a type similar to one being built at Harwell.

Production Commenced

Evans Medical Supplies Ltd., who were appointed agents for the Burma Pharmaceutical Industry in October, 1953, have been informed that work has started in the temporary production unit of the BPI. The project is expected to be completed by the autumn of next year.

Metal Colours' Explosion

Metal Colours of Slough, whose factory was wrecked by an explosion last week, hope to start production of chemicals within the next two weeks. Some machinery which escaped damage in the explosion at Oxford Avenue has been transferred to another of the firm's factories nearby. It is estimated that it will be 18 months before the wrecked factory is fully restored.

Fresh Fish—No Colour

In the annual report of the Food Investigation Board there is a description of experiments by scientists at the Torry, Aberdeen, research station for determining the freshness of fish. The scientists found that papers impregnated with tetrazolium salt changed colour when laid on the wet surfaces of fish no longer fresh. It was also found that comparatively fresh fish which had not been kept for more than a week in ice produced no colour. Stale and putrid fish quickly turned the test papers a deep purplish red.

Goblins in the cleaning tank?

The addition of small amounts of Sequestrol (ethylene diamine tetra-acetic acid Geigy) to both acid and alkaline cleaners for metals, whether simple immersion or electrolytic in type, often much improves their action by solubilising the more intractable surface films of oxide, carbonate etc. Cleaners formulated from concentrated Sequestrol solutions are valuable for specialised applications, for example, alkaline electrolytic de-rusting, cleaning of brazed assemblies, removal of welding flux, etc. Particulars on request.

a pinch of
SEQUESTROL
may be the answer

THE GEIGY COMPANY LTD. Geigy Rhodes, Middleton, MANCHESTER

E.30

OVERSEAS

US Tin Recovery

Secondary tin recovered as metal and in chemical compounds by detinning plants in the US increased by four per cent last year. The total recovered was 3,690 short tons compared with 3,550 in 1953. Tin-plate clippings and old cans were the source of 3,570 tons.

Israel's Chemical Expansion

Fertilisers & Chemicals, Israels $8,000,000 chemical combine, are stepping-up potassium sulphate and phosphoric acid output. Last week in the Haifa Bay area the company opened two new production units. The potassium sulphate plant has a capacity of 14,000 tons; the phosphoric acid unit 7,500 tons, but is designed to double this figure at a later stage.

Pakistan Chromite Output Down

Chromite production in Pakistan was down from 23,442 tons in 1953 to 21,863 tons last year. The main producers were Pakistan Chrome Mines Ltd. and Pakistan Industries Ltd. There was a considerable drop in prices towards the end of the year owing to a sharp decrease in overseas demands. The Government is considering granting compensation to the mine owners.

Atomic Energy for Electric Power

In a recent speech in Cologne, Professor Arthur Compton, Nobel Prize winner and leading American nuclear physicist, said he believed that Britain would be quicker than the US in developing atomic energy for the generation of electric power.

Commonwealth Oil

The capacity of Commonwealth oil refineries at the end of 1954 totalled 77,000,000 tons, an increase of 12,000,000 on the 1953 output, reports the Petroleum Information Bureau in London. The UK and Canada, each with just over 29,000,000 tons refining capacity, are the most important producing countries within the Commonwealth. The US is the largest refining country—just over half the world's entire capacity of 820,000,000 tons. Western Europe has become the leading area outside the US with over 100,000,000 tons, including the UK output. Leading European refiner is France (27,000,000 tons).

New Copper & Nickel Smelter

Between $17,000,000 and $20,000,000 will be spent on the construction of a copper and nickel smelter at Chicoutimi, Quebec, Premier Duplessis has announced. Mr. Duplessis said the figures were given by Andrew Robertson, a director of Eastern Refining and Smelting who will build the plant. The Premier said the company is also interested in establishing a chemical fertiliser plant in the province.

Football Pools Finance Science

Scientific and research institutions in Norway will benefit from the profits made by the State Football Pool last year. The profits are to be shared between science and sport. Of last year's profits, science will receive £1,060,000. Of this more than £600,000 goes to the research council for technical, agricultural, and general science, who in turn make grants to individuals.

Multi-Million Sulphuric Acid Plant

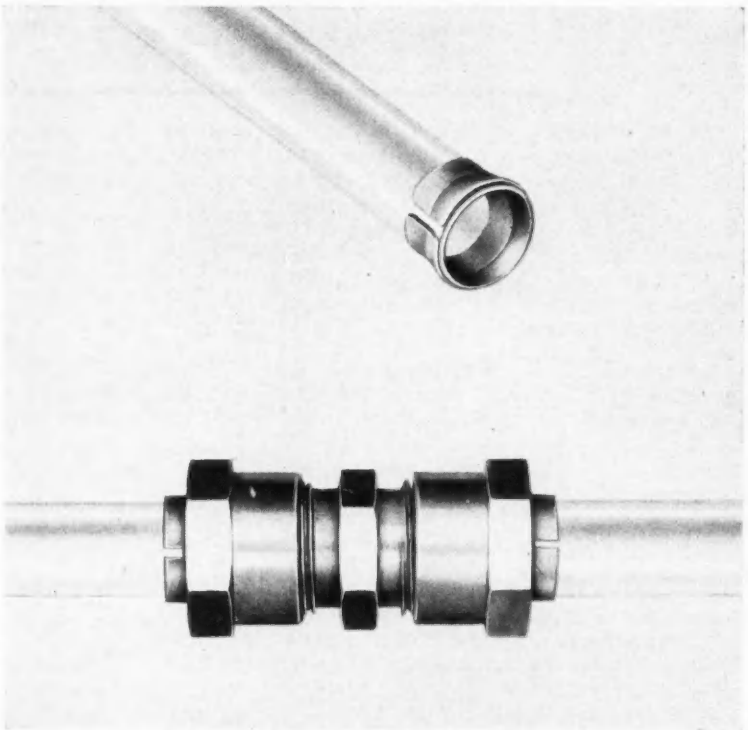
Noranda Mines Ltd. announce plans for constructing a multi-million dollar sulphuric acid plant in Algoma, Ontario, to meet the needs of Algoma Uranium and Consolidated Dennison Mines working in uranium fields north of Blind River. Negotiations for building the plant on 125 acres on the Sepent River Indian Reserve at Cutler, 20 miles east of Blind River, have begun. It is planned to have the plant in production by July next year, with a production capacity of 500 tons of acid a day.

Government Finance Paper Research

The Canadian Government is to finance a $2,000,000 pulp and paper research laboratory to be operated by the Pulp & Paper Research Institute of Canada. Plans are well advanced, and the project may be completed by the end of next year.

US Must Change Atomic Policy

Mr. Gordon Dean, former chairman of the Atomic Energy Commission, has charged the US with failing to carry out President Eisenhower's 'Atoms for Peace' plan. If the US did not change its policy and take power-producing atomic reactors off the secret list, Britain would step in, and the Soviet Union might beat the US to the 'golden opportunity', said Mr. Dean.



Re-usable . . .

FLARED PIPE COUPLINGS

The answer to corrosive fluids and gases. For Plastic and Metal Pipes of all sizes.

Supplied in ever increasing quantities to The Chemical and Allied Industries.

For further enquiries . . .

HIGH PRESSURE COMPONENTS LTD.

"SUNFLEX WORKS"
COLHAM MILL RD., WEST DRAYTON, MIDDX.
West Drayton 2226/7

PERSONAL

MR. C. G. F. PRITCHETT, M.I.E.E., A.C.G.I., has taken over the position of chief engineer to Chloride Batteries Ltd., Exide Works, Clifton Junction, Swinton, Manchester, in succession to the late MR. C. P. LOCKTON. Mr. Pritchett, who has been engaged in the battery industry since 1925, became a director of Chloride Batteries Ltd. in May 1952.

Seven appointments have been made to the board of directors of three of the subsidiary companies of Kelvin & Hughes Ltd. To the board of Kelvin & Hughes (Aviation) Ltd.: MR. F. W. BATES, who was recently appointed to the board of the parent company; Mr. R. W. DUNN, chief engineer (Aviation Instrument), MR. D. H. PERKINS, works manager, Kelvin Hughes Works, Basingstoke, Hampshire; and MR. G. WIKKENHAUSER, chief development engineer at the company's Barkingside, Essex, factory. To the board of Kelvin & Hughes (Industrial) Ltd.: MR. P. J. A. TURNER, A.M.I.E.E., chief engineer at the company's Glasgow factory. To the board of Kelvin & Hughes (Marine) Ltd.: MR. H. R. WHITFIELD, chief radar engineer, and MR. R. M. STEPHENSON, overseas sales manager of the company.

In Stockholm, on Saturday, 18 June, delegates from the 37 member countries of the International Organisation for Standardisation (ISO), elected as their fourth president, SIR ROGER DUNCALFE, president of the British Standards Institution. The election took place in the triennial General Assembly of ISO, and Sir Roger will hold the presidency for three years from 1 January next year. As chairman of British Glues & Chemicals Ltd., Sir Roger Duncalfe is a leader of Britain's chemical industry. He has been closely associated with standards work and the BSI for more than 20 years.

PROFESSOR PAUL DIRAC (Cambridge), who won the Nobel Prize for Physics in 1933, and PROFESSOR WILLIAM ASTBURY (Leeds), an authority on textile physics are to visit Russia in the autumn to lecture Moscow University students. The invitations result from contacts made when a team of Russian scientists visited this country recently. In Leeds Professor Astbury met and exchanged views with PROFESSOR V. A. ENGELHART, Russia's leading biochemist.

The Ministry of Agriculture, Fisheries and Food have appointed MR. EDGAR LEWIS, F.R.I.C., M.I.Chem.E., of Swansea, to be a member of the Local Fisheries Committee constituted for the South Wales Sea Fisheries District under the Sea Fisheries Regulation Acts, 1888 to 1930, as amended by the Sea Fish Industry Act 1938. The appointment is for the triennial period 1955/1958.

After 65 years' service with Daniel C. Griffith & Co., assayers, analytical chemists and samplers, MR. CHARLES EMMONEY, for several years senior ore and metal sampler, has retired. Mr. Emmoney joined the company in 1890 and was tutored by MR. DANIEL C. GRIFFITH, founder of the firm 100 years ago. The company presented Mr. Emmoney with a cheque and an easy chair.

MR. E. BASIL GREEN, the present managing director and deputy-chairman of Doulton & Co., has been elected chairman of the company.

Wills

MR. JOHN WILLIAM BROWN, Pinewood, Grayshott, Surrey, late managing director of Brown & Forth, chemical merchants and importers, left £41,029 net (duty paid £14,498).

MR. ERNEST WILLIAM MANN, former managing director of Southall Bros. & Barclay (1953) Ltd., and three times president of the Birmingham Pharmaceutical Association, left £31,625 (£31,576).

Obituary

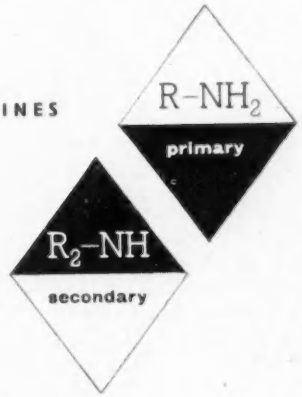
PROFESSOR ROBERT HENRY ADERS PLIMMER, Emeritus Professor of Chemistry in the University of London and a leading authority on protein chemistry, vitamin chemistry and biochemistry died in hospital on Saturday, 18 June, at the age of 78. Professor Plimmer was a founder member of the Biochemical Society and its first secretary and treasurer.

HIGH MOLECULAR WEIGHT ALIPHATIC AMINES

armeens

AND AMINE ACETATES

armacs



The Chemical Division of Armour & Co. Ltd. have detailed technical information on applying their ARMEENS and ARMACS in many industries. We may have a ready-to-use formula to fit your case.

ARMEENS are a range of primary aliphatic amines RNH_2 or secondary aliphatic amines R_2NH in which R represents pure or mixed fatty acid radicals. *Armeens* are strongly cationic and water repellent, and dissolve in oils and most solvents. They are substantive to metals, pigments, fibres, paper, glass, masonry, stones, plants, synthetic resins, etc. They are capable of additive and other chemical reactions.

ARMACS are the acetate salts of the ARMEENS and are water soluble. In all other respects they resemble the Armeens.

ARMEENS and ARMACS will shortly be produced together with other ARMOUR CHEMICALS in the United Kingdom. Samples and experimental lots are available now. Write to us on your business paper.

ARMOUR & COMPANY LTD., Chemical Division, Lindsey St., London, E.C.1

CI

British Chemical Prices

(These prices are checked with the manufacturers, but it must be pointed out that in many cases there are variations according to quantity, quality, place of delivery, etc.)

LONDON.—New business in chemicals during the past week has been about the usual level for the period and deliveries to the chief consuming ndustries have now been the chief consuming industries have now been a steady flow of export inquiry but the difficulties caused by the dock strike have held up shipments. Prices generally are firm, the only notable change being a rise of £2 per ton in the quotation for copper sulphate due to the higher cost of the metal. The coal tar products market is firm and unchanged. Cresylic acid prices are increased by 3d. per gallon as from 1 July.

MANCHESTER.—While consumers of heavy chemical products in the Lancashire district managed to maintain operations surprisingly well during the period of the rail dispute, many of them were not able to do without making serious inroads into reserves. In consequence the past week has witnessed a persistent flow of inquiries on the Manchester market for pretty well all descriptions of the soda and potash compounds and other leading lines. The light and heavy coal-tar products have also been active.

GLASGOW.—The week opened with the rail strike still having its effect on the Scottish heavy chemical market. The settlement, however, has eased the position, although it will be some little time before normal conditions are resumed. Some advance in prices have to be reported, due to increased transport charges. The demand for agricultural chemicals still continues steady.

General Chemicals

Acetic Acid.—Per ton : 80% technical, 10 tons, £83 ; 80% pure, 10 tons, £89 ; commercial glacial, 10 tons, £91 ; delivered buyers' premises in returnable barrels (technical acid barrels free) ; in glass carboys, £7 ; demijohns, £11 extra.

Acetic Anhydride.—Ton lots d/d, £123 per ton.

Alum.—Ground, about £25 per ton, f.o.r. MANCHESTER : Ground, £25.

Aluminium Sulphate.—Ex works, £14 15s. per ton d/d. MANCHESTER : £14 10s. to £17 15s.

Ammonia, Anhydrous.—1s. 9d. to 2s. 3d. per lb.

Ammonium Bicarbonate.—2-cwt. non-returnable drums : 1-ton lots, £49 per ton.

Ammonium Chloride.—Per ton lot, in non-returnable packaging, £27 17s. 6d.

Ammonium Nitrate.—D/d, £31 per ton (in 4-ton lots).

Ammonium Persulphate. — MANCHESTER : £6 5s. per cwt. d/d.

Ammonium Phosphate.—Mono- and di-, ton lots, d/d, £97 and £94 10s. per ton.

Antimony Sulphide.—Crimson, 4s. 4d. to 4s. 9½d. ; golden, 2s. 7½d. to 4s. 0¾d. ; all per lb., delivered UK in minimum 1-ton lots.

Arsenic.—Per ton, £45 to £50 ex store.

Barium Carbonate.—Precip., d/d : 4-ton lots, £39 per ton ; 2-ton lots, £39 10s. per ton, bag packing.

Barium Chloride.—£42 15s. per ton in 2-ton lots.

Barium Sulphate (Dry Blanc Fixe).—Precip., 4-ton lots, £42 10s. per ton d/d ; 2-ton lots, £43 per ton d/d.

Bleaching Powder.—£27 17s. 6d. per ton in returnable casks, carriage paid station, in 4-ton lots.

Borax.—Per ton for ton lots, in hessian sacks, carriage paid : Technical, anhydrous, £60; granular, £40 ; crystal, £42 10s. ; powder, £43 10s. ; extra fine powder, £44 10s. ; BP, granular, £49 ; crystal, £51 10s. ; powder, £52 10s. ; extra fine powder, £53 10s.

Boric Acid.—Per ton for ton lots, in hessian sacks, carriage paid : Technical, granular, £68 10s. ; crystal, £76 10s. ; powder, £74; extra fine powder, £76; BP granular, £81 10s. ; crystal, £88 10s. ; powder, £86 ; extra fine powder, £88.

Calcium Chloride.—Per ton lots, in non-returnable packaging : solid, £15 ; flake, £16.

Britain's Atomic Factories

The whole of the pipework in the highly and medium radio-active areas on the primary separation plant and vessels in the highly active section of Britain's Atomic Factories were fabricated in stainless steel and installed by Ashmore, Benson, Pease & Company. Using many welding sets, in conjunction with Argon arc sets, Ashmore's installed over ten miles of pipework with 40,000 butt-welded pipe joints and completed five miles of plate and sheet welding. Twenty-five X-ray sets were employed and extensive use made of radio-active isotopes. Approximately 60,000 radiographs were filed.

THE POWER-GAS CORPORATION LIMITED
AND
ASHMORE, BENSON, PEASE & COMPANY

STOCKTON-ON-TEES AND LONDON

AUSTRALIA · CANADA · FRANCE · INDIA · SOUTH AFRICA

Chlorine, Liquid.—£36 7s. 6d. per ton, in returnable 16-17-cwt. drums, delivered address in 3-drum lots.

Chromic Acid.—2s. 0⅜d. per lb., less 2½%, d/d UK, in 1-ton lots.

Chromium Sulphate, Basic.—Crystals, 7⅞d. per lb. delivered (£73 10s. per ton).

Citric Acid.—1-cwt. lots, £10 5s. cwt. ; 5-cwt. lots, £10 cwt.

Cobalt Oxide.—Black, delivered, bulk quantities, 13s. 2d. per lb.

Copper Carbonate.—2s. 9d. per lb.

Copper Sulphate.—£103 per ton f.o.b., less 2% in 2-cwt. bags.

Cream of Tartar.—100%, per cwt., about £10 12s.

Formaldehyde.—£37 5s. per ton in casks, d/d.

Formic Acid.—85%, £86 10s. in 4-ton lots, carriage paid.

Glycerine.—Chemically pure, double distilled 1.260 S.G., £13 3s, 6d. to £13 14s. 6d. per cwt. Refined pale straw industrial, 5s. per cwt. less than chemically pure.

Hydrochloric Acid.—Spot, about 12s. per carboy d/d, according to purity, strength and locality.

Hydrofluoric Acid.—59/60%, about 1s. 3d. to 1s. 6d. per lb.

Hydrogen Peroxide.—27.5% wt. £124 10s. per ton. 35% wt. £153 per ton d/d. Carboys extra and returnable.

Iodine.—Resublimed B.P., 17s. 7d. per lb., in 28-lb. lots.

Iodoform.—£1 6s. 7d. per lb., in 28-lb. lots.

Lactic Acid.—Pale tech., 44 per cent by weight £122 per ton ; dark tech., 44 per cent by weight, £73 per ton ex-works ; chemical quality, 44 per cent by weight, £112 per ton, ex-works ; 1-ton lots, usual container terms.

Lead Acetate.—White : About £142 10s. per ton.

Lead Nitrate.—About £132 10s. 1-ton lots.

Lead, Red.—Basis prices per ton. Genuine dry red, £132 5s. ; orange lead, £144 5s. Ground in oil : red, £150 ; orange, £162.

Lead, White.—Basis prices : Dry English in 5-cwt. casks, £137 10s. per ton. Ground in oil : English, 1-cwt. lots, 178s. per cwt.

Lime Acetate.—Brown, ton lots, d/d, £40 per ton ; grey, 80-82%, ton lots, d/d, £45 per ton.

Litharge.—£134 5s. per ton, in 5-ton lots.

Magnesite.—Calcined, in bags, ex-works, about £21 per ton.

Magnesium Carbonate.—Light, commercial, d/d, 2-ton lots, £84 10s. per ton, under 2 tons, £92 per ton.

Magnesium Chloride.—Solid (ex-wharf), £16 per ton.

Magnesium Oxide.—Light, commercial, d/d, under 1-ton lots, £245 per ton.

Magnesium Sulphate.—Crystals, £16 per ton.

Mercuric Chloride.—Technical Powder, £1 8s. 9d. per lb., in 5-cwt. lots ; smaller quantities dearer.

Mercury Sulphide, Red.—£1 11s. 3d. per lb., for 5-cwt. lots.

Nickel Sulphate.—D/d, buyers UK £170 per ton. Nominal.

Nitric Acid.—80° Tw., £35 per ton.

Oxalic Acid.—Home manufacture, minimum 4-ton lots, in 5-cwt. casks, about £130 per ton, carriage paid.

Phosphoric Acid.—Technical (S.G. 1.700) ton lots, carriage paid, £92 per ton ; B.P. (S.G. 1.750), ton lots, carriage paid, 1s. 3½d. per lb.

Potash, Caustic.—Solid, £93 10s. per ton for 1-ton lots ; Liquid, £36 5s.

Potassium Carbonate. — Calcined, 96/98%, about £63 per ton for 1-ton lots, ex-store.

Potassium Chloride.—Industrial, 96%, 1-ton lots, about £24 per ton.

Potassium Dichromate.—Crystals and granular, 1s. 1d. per lb., in 1-ton lots, d/d UK.

Potassium Iodide.—B.P., 14s. 1d. per lb. in 28-lb. lots ; 13s. 7d. in cwt. lots.

Potassium Nitrate.—In 4-ton lots, in non-returnable packaging, paid address, £63 10s. per ton.

Potassium Permanganate.—BP, 1-cwt. lots, 1s. 9d. per lb. ; 3-cwt. lots, 1s. 8½d. per lb. ; 5-cwt. lots, 1s. 8d. per lb. ; 1-ton lots, 1s. 7¾d. per lb. ; 5-ton lots, 1s. 7¼d. per lb. ; Tech., 5-cwt. packed in 1-cwt. drums, £8 14s. 6d. per cwt. ; packed in 1 drum, £8 9s. 6d. per cwt.

Salammoniac.—Per ton lot, in non-returnable packaging, £45 10s.

Salicylic Acid. — MANCHESTER : Technical 2s. 7½d. per lb. d/d.

Soda Ash.—58% ex-depot or d/d, London station, about £15 5s. 6d. per ton, 1-ton lots.

Soda, Caustic.—Solid 76/77% ; spot, £26 to £28 per ton d/d (4 ton lots).

Sodium Acetate.—Commercial crystals, £91 per ton d/d.

Sodium Bicarbonate.—Per ton lot, in non-returnable packaging, £15 10s.

Sodium Bisulphite. — Powder, 60/62%, £41 to £43 per ton d/d in 2-ton lots for home trade.

Sodium Carbonate Monohydrate.—Per ton lot, in non-returnable packaging, paid address, £59 5s.

For a quick insect knock down

AFRICAN PYRETHRUM PACKS A POWERFUL PUNCH

a punch that knocks 'em down and keeps 'em down

PYRETHRUM insecticides, although deadly to insects, are absolutely harmless to man and animals and can be used with the utmost safety in close proximity to foodstuffs.

PYRETHRUM is compatible with other insecticides and is capable of a high degree of synergism.

PYRETHRUM used in low concentrations with suitable synergists, combines high knock-down rate with effective killing power — moreover insects do not develop resistance to Pyrethrum based insecticides.

PYRETHRUM IS A MUST IN THE FORMULATION OF ALL HIGHLY COMPETITIVE MODERN INSECTICIDES.

Detailed information and advice on the formulation of Pyrethrum insecticides for Domestic, Industrial and Horticultural purposes available on request.

AFRICAN PYRETHRUM

MITCHELL COTTS & CO. LTD.,
Winchester House, Old Broad Street, London, E.C.2
Telephone: LONdon Wall 6000

Overseas Agents to:—
The Pyrethrum Board of Kenya, NAKURU, Kenya Colony.
The Pyrethrum Board of Tanganyika, MBEYA, Tanganyika Territory.
Societe Co-operative des Produits Agricoles, GOMA, Belgian Congo.

Sodium Chlorate.—About £75 per ton in free 1-cwt. drums, carriage paid station, in 4-ton lots.

Sodium Cyanide.—96/98%, £113 5s. per ton lot in 1-cwt. drums.

Sodium Dichromate.—Crystals, cake and powder, 10¾d. per lb. Net d/d UK, minimum 1-ton lots; anhydrous, 1s. 0½d. per lb. Net del. d/d UK, minimum 1-ton lots.

Sodium Fluoride.—Delivered, 1-ton lots and over, £4 15s. per cwt.; 1-cwt. lots, £5 5s. per cwt.

Sodium Hyposulphite.—Pea crystals £34 15s. a ton; commercial, 1-ton lots, £31 10s. per ton, carriage paid.

Sodium Iodide.—BP, 17s. 1d. per lb. in 28-lb. lots.

Sodium Metaphosphate (Calgon).—Flaked, loose in metal drums, £127 per ton.

Sodium Metasilicate.—£24 per ton, d/d UK in ton lots, loaned bags.

Sodium Nitrate.—Chilean Industrial, over 98% 6-ton lots, d/d station, £27 10s.

Sodium Nitrite.—£32 per ton (4-ton lots).

Sodium Percarbonate.—12½% available oxygen, £8 2s. 10½d. per cwt. in 1-cwt. drums.

Sodium Phosphate.—Per ton d/d for ton lots: Di-sodium, crystalline, £37 10s., anhydrous, £81; tri-sodium, crystalline, £39 10s., anhydrous, £79.

Sodium Silicate.—75-84° Tw. Lancashire and Cheshire, 4-ton lots, d/d station in loaned drums, £10 15s. per ton; Dorset, Somerset and Devon, £3 17s. 6d. per ton extra; Scotland and S. Wales, £3 per ton extra. Elsewhere in England, excluding Cornwall, and Wales, £1 12s. 6d. per ton extra.

Sodium Sulphate (Glauber's Salt).—About £8 10s. per ton d/d.

Sodium Sulphate (Salt Cake).—Unground. £6 per ton d/d station in bulk. MANCHESTER: £6 10s. per ton d/d station.

Sodium Sulphide.—Solid, 60/62%, spot, £33 2s. 6d. per ton, d/d, in drums; broken, £33 2s. 6d. per ton, d/d, in drums.

Sodium Sulphite.—Anhydrous, £59 per ton; pea crystals, £37 12s. 6d. per ton d/d station in kegs; commercial, £23 7s. 6d. per ton d/d station in bags.

Sulphur.—Per ton for 4 tons or more, ground, £20 to £22, according to fineness.

Sulphuric Acid.—Net, naked at works, 168° Tw. according to quality, per ton, £10 7s. 6d. to £12; 140° Tw., arsenic free, per ton, £8 12s. 6d.; 140° Tw., arsenious, per ton, £8 4s. 6d.

Tartaric Acid.—Per cwt.: 10 cwt. or more £12 10s.

Titanium Oxide.—Standard grade comm., with rutile structure, £162 per ton; standard grade comm., £142 per ton.

Zinc Oxide.—Maximum price per ton for 2-ton lots, d/d, white seal, £107; green seal, £105; red seal, 2-ton lots, £103 per ton.

Solvents & Plasticisers

Acetone.—Small lots: In 5-gal. cans: 5-gal., £125 10-gal. and upward, £115, cans included. In 40/45 gal. returnable drums, spot: Less than 1 ton, £90; 1 to less than 5 tons, £87; 5 to less than 10 tons, £86; 10 tons and upward, £85. In tank wagons, spot: 1 to less than 5 tons (min. 400 gal.), £85; 5 to less than 10 tons (1,500 gal.), £84; 10 tons and upward (2,500 gal.), £83; contract rebate, £2. All per ton d/d.

Butyl Acetate BSS.—£169 per ton, in 1-ton lots; £167 per ton, in 10-ton lots.

***n*-Butyl alcohol, BSS.**—10 tons, in drums, £154 per ton d/d.

***sec*-Butyl Alcohol.**—5 gal. drums £159; 40 gal. drums: less than 1 ton £124 per ton; 1 to 10 tons £123 per ton; 10 tons and over £122 per ton; 100 tons and over £120 per ton.

***tert*-Butyl Alcohol.**—5 gal. drums £195 10s. per ton; 40/45 gal. drums: less than 1 ton £175 10s. per ton; 1 to 5 tons £174 10s. per ton; 5 to 10 tons, £173 10s.; 10 tons and over £172 10s.

Diacetone Alcohol.—Small lots: 5 gal. drums, £177 per ton; 10 gal. drums, £167 per ton. In 40/45 gal. drums; less than 1 ton, £142 per ton; 1 to 9 tons, £141 per ton; 10 to 50 tons, £140 per ton; 50 to 100 tons, £139 per ton; 100 tons and over, £138 per ton.

Dibutyl Phthalate.—In drums, 10 tons, 2s. per lb. d/d; 45 gal. drums, 2s. ¾d. per lb. d/d.

Diethyl Phthalate.—In drums, 10 tons, 1s. 10¼d. per lb. d/d; 45 gal. drums, 1s. 11¾d. per lb. d/d.

Dimethyl Phthalate.—In drums, 10 tons, 1s. 7¼d. per lb. d/d; 45 gal. drums, 1s. 8¾d. per lb. d/d.

Dioctyl Phthalate.—In drums, 10 tons, 2s. 8d. per lb. d/d; 45 gal. drums, 2s. 9½d. per lb. d/d.

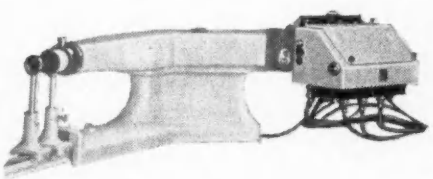
Ether BSS.—In 1 ton lots, 1s. 11d. per lb.; drums extra.

Ethyl Acetate.—10 tons lots, d/d, £133 per ton.

Spectrochemical Analysis

by direct reading methods

With the Direct Reading Attachment to the Hilger Medium Quartz Spectrograph



* **Rapid** (*Analyses a maximum of ten elements in less than three minutes*)
* **Accurate** (*Accuracy is limited only by sample heterogenity*)
* **Sensitive** (*Sensitivity is often superior to that obtained by using photographic means*)

On view at the British Instrument Industries Exhibition this year, together with further selections from our wide range of instruments for spectrochemical analysis and a tristimulus colorimeter. Our staff will be happy to arrange demonstrations for you, either at the Hilger stand or in our laboratories.

Tickets for the exhibition will be supplied on request to Hilger & Watts Ltd.

STAND No. 10F
B.I.I.E., EARLS COURT
JUNE 28 - JULY 9, 1955

HILGER & WATTS Ltd.
98 St. PANCRAS WAY
LONDON N.W.1

Member of the Scientific Instrument Manufacturers' Association and of SCIEX

Ethyl Alcohol (PBS 66 o.p.).—Over 300,000 p. gal., 2s. 9d. ; 2,500-10,000 p. gal., 2s. 11½d. per p. gal., d/d in tankers. D/d in 40/45-gal. drums, 1d. p.p.g. extra. Absolute alcohol (75.2 o.p.) 5d. p.p.g. extra.

Methanol.—Pure synthetic, d/d, £43 15s. per ton.

Methylated Spirit.—Industrial 66° o.p. : 500 gal. and over in tankers, 4s. 10d. per gal. d/d ; 100-499 gal. in drums, 5s. 2½d. per gal. d/d. Pyridinised 64 o.p. : 500 gal. and over in tankers, 5s. 0d. per gal. d/d ; 100-499 gal. in drums, 5s. 4½d. per gal. d/d.

Methyl Ethyl Ketone.—10-ton lots, £136 per ton d/d. ; 100-ton lots, £134 per ton d/d.

Methyl *iso*Butyl Ketone.—10 tons and over £167 per ton.

***iso*Propyl Acetate.**—In drums, 10 tons, £128 per ton d/d ; 45 gal. drums, £133 per ton d/d.

***iso*Propyl Alcohol.**—Small lots : 5-gal. drums, £118 per ton ; 10-gal. drums, £108 per ton ; in 40-45 gal. drums ; less than 1 ton, £83 per ton ; 1 to 9 tons £81 per ton ; 10 to 50 tons, £80 10s. per ton ; 50 tons and over, £80 per ton.

Rubber Chemicals

Carbon Bisulphide.—£61 to £67 per ton, according to quality.

Carbon Black.—8d. to 1s. per lb., according to packing.

Carbon Tetrachloride.—Ton lots, £76 10s. per ton.

India-Rubber Substitutes.—White, 1s. 5¾d. to 1s. 9½d. per lb. ; dark, 1s. 4d. to 1s. 6¾d. per lb. delivered free to customers' works.

Lithopone.—30%, about £54 per ton.

Mineral Black.—£7 10s. to £10 per ton.

Sulphur Chloride.—British, about £50 per ton.

Vegetable Lamp Black.—£64 8s. per ton in 2-ton lots.

Vermilion.—Pale or deep, 15s. 6d. per lb. for 7-lb. lots.

Nitrogen Fertilisers

Ammonium Sulphate.—Per ton, in 6-ton lots, d/d farmers' nearest station : March to June, £18.

Compound Fertilisers.—Per ton in 6 ton lots, d/d farmer's nearest station, I.C.I. Special No. 1. January to June, £25 14s.

'Nitro-Chalk.'—£15 14s. per ton in 6-ton lots, d/d farmer's nearest station.

Sodium Nitrate.—Chilean agricultural for 6-ton lots, d/d nearest station : May to June, £26 10s.

Coal-Tar Products

Benzole.—Per gal., minimum of 200 gals. delivered in bulk, 90's, 5s. ; pure, 5s. 4d.

Carbolic Acid.—Crystals, 1s. 4d. to 1s. 6½d. per lb. Crude, 60's, 8s. MANCHESTER : Crystals, 1s. 4½d. to 1s. 6½d. per lb., d/d crude, 8s. naked, at works.

Creosote.—Home trade, 1s. to 1s. 9d. per gal., according to quality, f.o.r. maker's works. MANCHESTER : 1s. to 1s. 8d. per gal.

Cresylic Acid.—Pale 99/99½%, 5s. 10d. per gal. ; 99.5/100%, 6s. per gal. D/d UK in bulk : Pale A.D.F. from 5s. 8d., per Imperial gallon, f.o.b.

Naphtha.—Solvent, 90/160°, 4s. 10d. per gal. ; heavy, 90/190°, 3s. 9½d. per gal for bulk 1000-gal. lots, d/d. Drums extra ; higher prices for smaller lots.

Naphthalene.—Crude, 4-ton lots, in buyers' bags, £17 5s. to £28 7s. per ton nominal, according to m.p. ; hot pressed, £40 per ton in bulk ex-works ; refined crystals, £56 10s. per ton d/d, mis. 4-ton lots.

Pitch.—Medium, soft, home trade, £9 per ton f.o.r. suppliers' works ; export trade about £10 10s. per ton f.o.b. suppliers' port.

Pyridine.—90/160°, £1 2s. 6d. to £1 5s. per gal.

Toluole.—Pure, 5s. 7d. ; 90's, 4s. 10d. per gal. d/d. MANCHESTER : Pure, 5s. 7d. per gal. naked.

Xylole.—For 1000-gal. lots, 5s. 10d. to 6s. per gal., according to grade, d/d London area in bulk.

Intermediates & Dyes (Prices Nominal)

***m*-Cresol** 98/100%.—4s. 3d. per lb. d/d.

***o*-Cresol** 30/31° C.—1s. 4d. per lb. d/d.

***p*-Cresol** 34/35° C.—4s. 3d. per lb. d/d.

Dichloraniline.—4s. 1d. per lb.

Dinitrobenzene.—88/89° C., 1s. 11d. per lb.

Dinitrotoluene.—S.P. 15° C., 1s. 11½d. per lb. ; S.P. 26° C., 1s. 3d. per lb. S.P. 33° C., 1s. 1½d. per lb. ; S.P. 66/68° C., 1s. 9d. per lb.

***p*-Nitraniline.**—4s. 7d. per lb.

Nitrobenzene.—Spot, 9½d. per lb. in 90-gal. drums, drums extra, 1-ton lots d/d buyers' works.

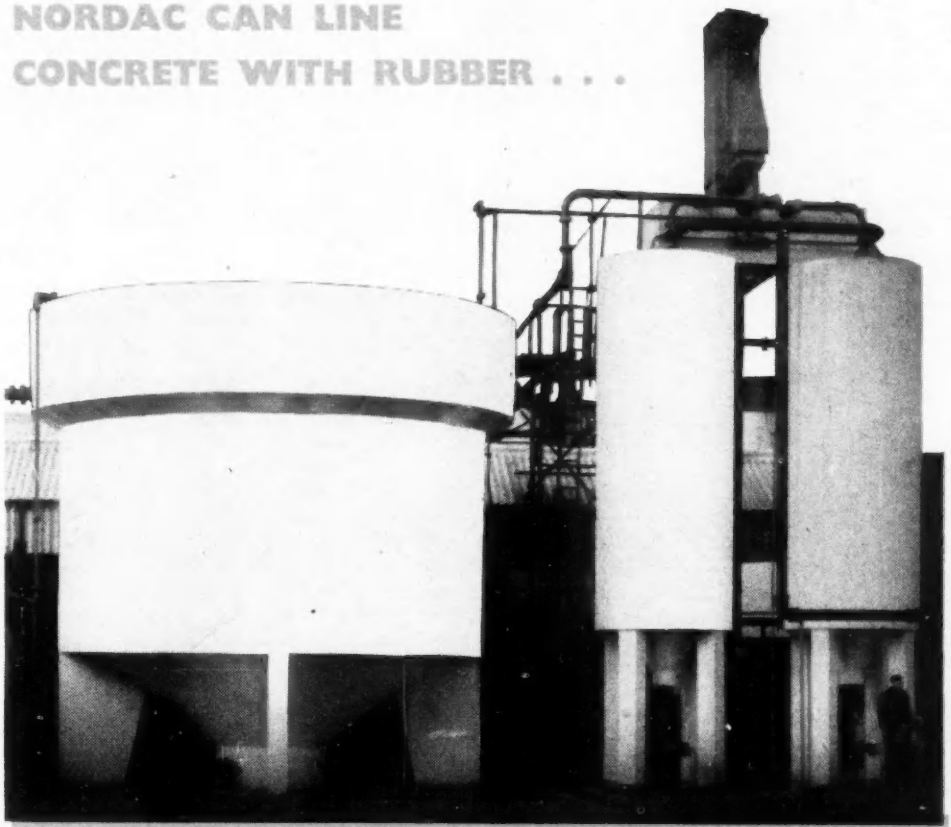
Nitronaphthalene.—2s. per lb.

***o*-Toluidine.**—1s. 9d. per lb., in 8/10-cwt. drums, drums extra.

***p*-Toluidine.**—5s. 6d. per lb., in casks.

Dimethylaniline.—3s. 1d. per lb., drums extra, carriage paid.

NORDAC CAN LINE CONCRETE WITH RUBBER . . .



Reaction and Settling Vessels lined by us at a large Chemical Works

. . . and also Steel, Cast Iron, Timber and Brick Structures

It was more than 30 years ago when Nordac Staff took their equipment to a Chemical Installation in Stratford, and successfully pioneered rubber lining of plant in situ. Since that time it has become the accepted practice to talk *first* to Nordac about work of this nature. The varying design and construction of chemical plant often calls for advice and treatment that can only be based on experience. This knowledge is at your disposal and your inquiries will have our prompt attention.

NORDAC LIMITED

CHEMICAL ENGINEERS

UXBRIDGE, MIDDLESEX

Telephone : Uxbridge 5131-4. Telegrams : Nordac, Uxbridge

Chemical & Allied Stocks & Shares

STOCK markets have been outstandingly strong, and in the industrial sections boom-like conditions ruled at times with many leading shares reaching new peak levels. Buying, though persistent and substantial, was much less than might have been deduced from the advance in values. In fact the big upswing in the latter has been stimulated a good deal by shortage of shares; owing to very little selling, the market is none too well supplied. Moreover, the advance received an impetus from US demand for some leading British shares. In fact, American buying has been on a bigger scale that at any time since the war, and the assumption is that it is likely to increase further.

A factor helping sentiment in stock markets has been the fact that more companies are bringing out profit sharing or co-partnership schemes, many of which involve the issue of shares to employees. At the company's annual meeting Dr. Alexander Fleck dealt in detail with the working of I.C.I's big profit sharing scheme and also hoped that employees would take advantage of the additional facility given to them by the company to buy shares at slightly under the Stock Exchange price. An interesting point raised by a shareholder at the meeting, whether they might wake up one morning and find the Trustees for the employees' shares in control of the company, received the reply from Dr. Fleck, that in 30 years' time only 10 per cent to 15 per cent of the equity capital would be held by the workers. Courtaulds are to announce their co-partnership scheme in a few days.

Compared with a month ago, Imperial Chemical shares have advanced from 47s. 9d. to the new record level of 56s. 10½d. At the meeting the chairman also revealed that the company are to start the issue of half-yearly statements showing the trend of earnings, though it will not give audited profits. Monsanto already issue a half-yearly statement.

Fisons shares have risen on the month from 55s. to 64s. 3d. and Albright & Wilson 5s. shares were 22s. 9d. 'ex' the free scrip issue. Anchor Chemical 5s. shares were quoted at 13s. while in other directions, Laporte 5s. shares have been a strong feature, helped by the full results and annual statement, and have risen on the month from 16s. 6d. to 21s.xd. F. W. Berk 2s. 6d. shares strengthened from 8s. 6d. to 9s. 7½d., and Yorkshire Dyeware & Chemical 5s. shares from 11s. 9d. to 12s. 6d. Monsanto 5s. shares rose from 30s. 3d. to 35s. 6d., and Reichhold 5s. shares from 17s. 6d. to 19s. 3d. Elsewhere, Lawes' Chemical 5s. shares were 16s. against 14s. 3d. a month ago.

Boake Roberts 5s. shares responded to the dividend and were 16s. 3d., compared with 15s. 7½d. a month ago. William Blythe 3s. shares at 18s. moved slightly higher on balance, and Burt Boulton & Haywood were 35s. against 31s. 10½d.

There was strong buying of Hickson & Welch 10s. shares, which have moved up from 24s. to 25s. 9d., while Hardman & Holden 5s. shares strengthened from 14s. 1½d. to 15s. Greeff-Chemicals Holdings 5s. shares firmed up to 17s. 1½d.

Borax Consolidated were an outstanding feature of strength on hopes of a tax concession in respect of the group's earnings from mining in the US. These shares have advanced to as much as 144s. 6d., compared with 125s. 6d. a month ago. Among plastics, British Xylonite rose from 40s. to 45s. British Industrial Plastics 2s. shares were up from 5s. 10½d. to 6s. 10½d.

In other directions, Boots Drug rose from 24s. 9d. to 39s. 9d. under the influence of the record results. Courtaulds advanced on the month from 46s. 3d. to 50s. 6d. and British Celanese from 29s. 9d. to 32s. 3d. Unilever were 89s., against 82s,. a month ago. The units of the Distillers Co. advanced from 27s. 3d. to 32s. 3d. pending the dividend announcement.

Table Jelly Order

THE Minister of Agriculture, Fisheries and Food, and the Secretary of State for Scotland have amended the Food Standards (Table Jellies) Order, 1949 (SI. 1949, No. 1656).

These orders prescribe an alternative to the present standard for table jelly crystals of a minimum of 84 per cent sugar content. The alternative standard, which enables low setting gelatine to be used in the manufacture of table jelly crystals, requires that when table jelly crystals are made up into a table jelly sweet each pint of the finished product shall contain not less than 2½ oz. of sugar.

"Many difficulties occur in the pursuits of the dairy farmer which render his occupation precarious. Such difficulties arise entirely from an ignorance of the scientific relations of the practice in which he is engaged."

Such difficulties arise

Evidently the scientific approach to dairy farming was already an active force 112 years ago, for the sentences quoted come from a paper 'On the Changes in Composition of the Milk of a Cow according to its Exercise and Food' delivered by Dr. Lyon Playfair in January 1843 and recorded in the first issue of the Journal of the Chemical Society. Modern dairy physiologists prefer to use a herd, or identical twin cattle, in their feeding tests, rather than the one cow of Dr. Playfair. Dairy analysts also seek greater accuracy in their control methods and find it by using B.D.H. reagents specifically prepared for milk testing purposes :—

STANDARD METHYLENE BLUE TABLETS
RESAZURIN TABLETS
RINGER'S SOLUTION TABLETS
BUFFER SUBSTRATE TABLETS FOR THE PHOSPHATASE TEST
FOLIN & CIOCALTEU'S REAGENT
SODIUM PHENYL PHOSPHATE
SODIUM *p*-NITROPHENYL PHOSPHATE

B.D.H.
LABORATORY CHEMICALS

THE BRITISH DRUG HOUSES LTD. B.D.H. LABORATORY CHEMICALS GROUP POOLE DORSET
LC.P/10 bt

Law & Company News

Commercial Intelligence

The following are taken from the printed reports, but we cannot be responsible for errors that may occur.

Mortgages & Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described herein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages or Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary but such total may have been reduced.)

POLIVIT MANUFACTURING CO. LTD., London S.E., manufacturers of chemical cleaners, etc.—13 May, £653 debentures (dated 10 May, 1955), to F. N. Dowson, Kingston-on-Thames; general charge. *£653. 11 May, 1955.

SADLER & CO. (CHEMICALS) LTD., Middlesbrough, tar manufacturers.—13 May, mortgage and charge, to National Provincial Bank Ltd. securing all moneys due or to become due to the bank; charged on property at Cargo Fleet Road, Middlesbrough, and a general charge.

Changes of Address

Fisons Ltd. are moving to new quarters in Berwick-on-Tweed. Their address from 1 July will be: Fisons Ltd., Harvest House, Spittal, Berwick-on-Tweed. Telephone: Berwick 529.

F. W. Ball Ltd., manufacturing chemists, from 33 Brewery Road, London N.7, to 1 North Road, London N.7.

Rhoden Partners Ltd., specialists in the design and development of plant and machinery, have moved from 6 Ganton Street, London W.1, to larger premises at 51 North Row, London W.1 (Tel.: MAYfair 6248). They will now be able to expand their drawing offices and to provide additional drafting, tracing and illustrating services, which they undertake on a contract basis. In addition, site surveys can now be carried out and installation drawings prepared. A photo-printing department is being formed and closer relations between the design office and the prototype workshop will be established.

Company News

British Emulsifiers

British Emulsifiers have agreed to acquire the £25,000 capital of Royston Engineering for £50,000 in cash—to be provided from own resources—and the allotment of 1,000,000 shares of 1s. Mr. J. G. Leach and Mr. R. A. J. Hill, technical directors of Royston, will join the board of British Emulsifiers.

British Celanese

British Celanese announce a final dividend of seven per cent, making 10 per cent for the year ended 2 April on the £7,518,534 ordinary stock as doubled by a free scrip issue. This is an increase of one per cent over the previous year's equivalent of nine per cent. Taxation charges are lower at £1,631,106, compared with £2,291,973; the net profit being some £67,000 down at £1,710,140. The increased ordinary dividend takes £426,677 against £372,168.

Indestructible Paint Co.

At the annual ordinary general meeting in London last Monday the directors of Indestructible Paint Co. recommended a final dividend of 13¾ per cent, which together with the interim dividend paid in October equals payment at the rate of 37½ per cent on the old capital. The sales of industrial coatings produced at the Birmingham factory were a record. In Sweden, where considerable expansion was carried out during the year, the turnover of the subsidiary company was also a record.

Greef-Chemicals Holdings

At the 19th AGM of the Greef-Chemicals Holdings, Mr. S. Bayliss Smith, F.C.A., presiding, a total distribution of 17½ per cent for the year on the ordinary capital of £400,000 was recommended. This compared with 25 per cent for 1953 on the ordinary capital as it was then of £200,000. An interim dividend of 3¾ per cent on the capital as increased was paid on 1 November, 1954, so that the proposed final dividend distribution will be 13¾ per cent. The turnover of the group for 1954 was the highest recorded, and this year as business has continued on a high level the company is to take over bigger premises in Gresham Street, London E.C.2.

JMS

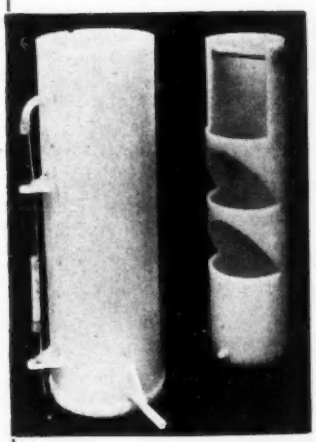
ORGANIC AND DYESTUFF INTERMEDIATES

Write Dept. B/15 for further details

J.M.STEEL & CO.LTD.
36/38. KINGSWAY LONDON W.C.2 *Tel.* HOLborn 2532/5
BRANCH OFFICES
51. SOUTH KING ST. MANCHESTER 2 *Tel.* Deansgate 6077/9
45. NEWHALL ST. BIRMINGHAM 3 *Tel.* Central 6342/3

NEW !

REDIWELD PIPETTE WASHING OUTFIT



fabricated in Polythene. Unbreakable, inert, resilient (pipette ends are not damaged due to the special construction of the retaining grid).

Enquiries to :—

REDIWELD LIMITED
15/17 CROMPTON WAY, CRAWLEY, SUSSEX

Notes on Microtechnique

continued from page 1466

mountant, and in addition it will be seen that the dilution technique employed has allowed the particles to settle into almost the same optical plane. This has the advantage of rendering great changes of focus, so often necessary and so aggravating when performing an extended examination, virtually unnecessary.

As has been remarked earlier, it is often desirable or necessary to mount certain specimens without the use of a mounting agent. For permanent preparations of this type the writer has devised a simple technique that has proved very effective. In the case of the finer specimens, as described under temporary preparations, these may be mounted directly on a slide in the following manner. In the centre of a clean microscope slide place one drop of a 1 per cent solution of gum damar, spread evenly over an area of about 1 cm. square, and dry the slide at 100°C in a water oven for one hour. Remove from the oven and allow to cool.

Sprinkle a very minute amount of the sample to be mounted on to the gummed surface, and then breathe very gently on to the slide. The warmth and moisture of the breath will cause the particles to adhere to the gum. The slide is again dried, preferably in the 37°C incubator to avoid damaging the sample, and then covered with a clean cover glass which is sealed into place with a cement such as gold size, or shellac, using the ringing turntable, and placing several rings of the cement around the edge of the cover glass.

The same method is employed in the case of the bulkier specimens, with the exception that a cell is used to hold the sample. The bottom of the cell is coated with a thin layer of the gum solution, and then dried as above. The procedure is then followed for the inserting of the specimen, the cell mount is dried, and a cover glass ringed in place.

It must be remembered with dry mounts that the thinner specimens, which may be mounted directly on to the slide, are accessible to the higher microscope magnifications, but the thicker specimens may require a cell so deep that they cannot be observed with a 1/6 objective. When examining such thick preparations care should be taken in focusing the microscope, it is a simple matter to rack the body down too far, and the objective may be driven down on to the mount, with possible serious damage to the optical system, and to the preparation.

Finally, it is essential to label all slides with the name of the specimen, the type of mountant, and the date. In addition a catalogue should be kept, in which is recorded every detail of the specimens treated, including sources, dates, mountants, and any other information available.

Refractive Indices of Some Suggested Temporary Mounting Agents

Cajeput oil	1.457
Carbon disulphide	1.630
Castor oil	1.490
Cedarwood oil	1.510
Creosote	1.538
Ethylene glycol	1.432
Isobutyl alcohol	1.397
Lactophenol	1.460
Olive oil	1.473
Liquid paraffin	1.471
Turpentine oil	1.473
Xylol	1.492

REFERENCES

(1) Preston, J., *Nature*, 1930, **125**, 564.
(2) Marshall, W., *Nature*, 1930, **125**, 564.
(3) Charlett, S. M., *Lab. Practice*, 1954, **3**, 300.
(4) Allen, R. P., *Ind. Eng. Chem.* Anal. Ed., 1942, **14**, 92.
(5) Miller, L. B., *Paper Tr. J.*, 1943, **116**, T.A.P.P.I. Sec. 9-12.
(6) Charlett, S. M., *Lab. Practice*, 1953, **2**, 660.
(7) Charlett, S. M., *Dairy Ind.*, 1954, **20**, 44.

Next Week's Events

WEDNESDAY 29 JUNE

RIC (London Section)

Bracknell: Visit to I.C.I. Research Station, Jeallott's Hill, Bracknell, Berkshire, 2 p.m.

Society for Analytical Chemistry

London: 'The Feathers', Tudor Street, London, E.C.4, 6.30 p.m. 'The Microdetermination of Molecular Weight' discussion.

FRIDAY 1 JULY

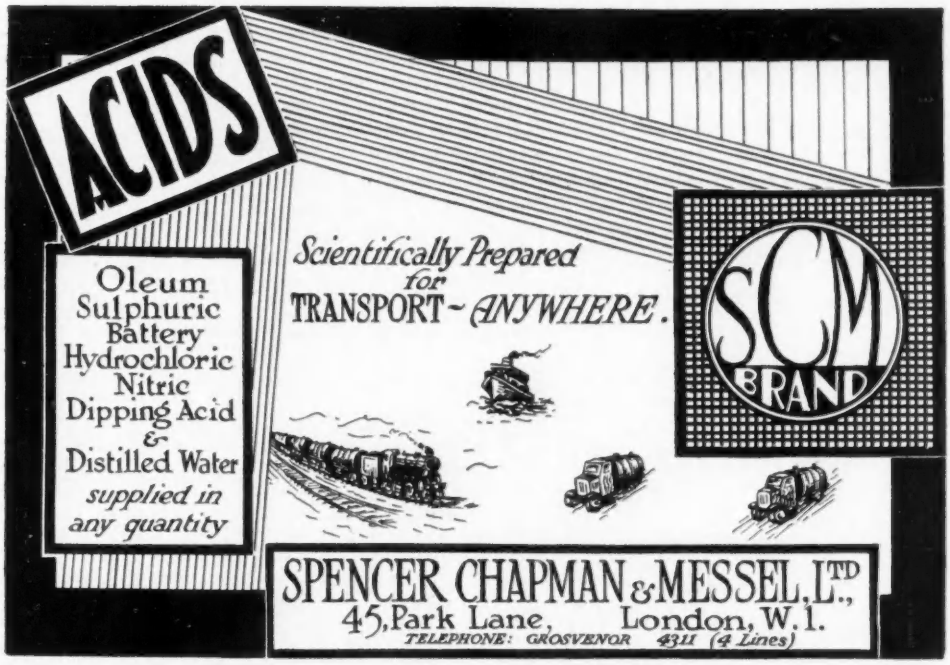
RIC (London Section)

Fulham: Visit to North Thames Gas Board, Fulham, S.W.6, 2.30 p.m.

SATURDAY 2 JULY

RIC (London Section)

Harwell & Shoreham: Visit to Atomic Energy Research Establishment, Harwell, Berkshire, 11 a.m. Visit to British Portland Cement Manufacturers Ltd., Shoreham, Sussex, 11 a.m.



SAFETY IN THE CHEMICAL INDUSTRY

Articles on Non-sparking Tools, Safe Floors, Bursting Discs, Fire Precautions, Protective Clothing, etc., have and will be regularly appearing in THE CHEMICAL AGE.

Readers are invited to send the name and address of any executive interested in these important subjects. A specimen copy will be sent free on request. Applications should be made to :—

THE PUBLISHER,
THE CHEMICAL AGE,
154, Fleet Street, London, E.C.4

LABORATORY FURNISHERS : "ANALAR" & LABORATORY REAGENTS PHOTOGRAPHIC CHEMICALS : SCIENTIFIC GLASSBLOWERS

McCULLOCH BROTHERS & WILSON
of
Glasgow

We supply, adapt, and repair all types of Laboratory Apparatus and Glassware ———— and our service is at your disposal.

36a-46a WEST PRINCES STREET, GLASGOW, C.4.
Phone: DOUGLAS 2046

CLASSIFIED ADVERTISEMENTS

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 *inclusive, or a woman aged* 18-59 *inclusive, unless he or she, or the employment, is excepted from the provisions of the Notifications of Vacancies Order,* 1952.

CABOT CARBON LIMITED have vacancies for **GRADUATE CHEMICAL ENGINEERS** to work in their factory at Stanlow and in their Research Department in the United States. Candidates would spend an initial training period at Stanlow working on plant development and quality control problems before being selected to join the American parent company to work on more fundamental chemical engineering problems.

Previous industrial experience is desirable though not essential.

Applications should be addressed to the **WORKS MANAGER, CABOT CARBON LIMITED, STANLOW, ELLESMERE PORT, CHESHIRE.**

CHEMICAL ENGINEERS are required by an established company manufacturing intermediates for the plastics industry. Applicants, aged 23-28, should have a sound academic background, and be able to apply their knowledge to the problems arising in the operation and development of chemical plant. The vacancies are in the Technical Department and the work will involve experimental investigations leading to the design and subsequent commissioning of new or modified process equipment. The work is varied and will appeal to men who wish to extend their experience without specialising in a narrow field. Applications, giving relevant details, which will be treated as confidential, should be addressed to **BOX No. C.A. 3412, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4,** quoting ref. R.85.

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY,
ALDERMASTON,
BERKS,
requires an
ENGINEER, GRADE II,
to be responsible for the efficient operation, maintenance, overhaul and replacement of mechanical engineering plant (particularly heating, ventilation and air-extraction plant) and chemical plant (water purification and effluent treatment plant) installed in or associated with the safe operation of laboratories handling radio-active and other highly toxic materials.

Applicants should have served a recognised engineering apprenticeship and should be either Corporate Members of one of the Institutions of Electrical or Mechanical Engineers, or possess exempting qualifications. Previous experience of the operation of plant dealing with radio-active or toxic materials and of the associated hazards is desirable. They should be able to initiate and advise on the design of special equipment.

SALARY.—£1,065-£1,370 per annum (male).

SUPERANNUATION.—The successful applicant will be required to join the Authority's Contributory Scheme.

HOUSING accommodation will be available within a reasonable period for married officers who live outside the radius of the Establishment's transport facilities, or alternatively, the Authority may be able to assist successful applicants in the purchase of a house.

Requests for application forms by **POST-CARD**, to:
SENIOR RECRUITMENT OFFICER,
A.W.R.E.,
ALDERMASTON, BERKS.
Quote Reference 675/WGE/38.

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY,
ALDERMASTON,
BERKS,
requires a
PHYSICAL CHEMIST
in the grade of
EXPERIMENTAL OFFICER,
to assist in a group engaged in the production and filling of initiation explosives and to undertake development work in this field.

The minimum qualification is Higher School Certificate (Science) or equivalent, but a Pass Degree in Chemistry is desirable. Previous experience in similar work an advantage. Applicants should be at least 26 years of age.

SALARY.—£775-£945 per annum (male). The successful applicant will be required to join the Authority's Contributory Superannuation Scheme.

HOUSING accommodation will be available within a reasonable period for married officers who live outside the radius of the Establishment's transport facilities, or alternatively, the Authority may be able to assist successful applicants in the purchase of a house. During this period a lodging allowance may be payable.

Requests for application forms by **POST-CARD** to
SENIOR RECRUITMENT OFFICER,
A.W.R.E.,
ALDERMASTON, BERKS.
Quote Reference 666/WGE/38.

SHELL RESEARCH, LTD., require a **CHEMIST,** 25-35 years of age, at their Agricultural Research Centre near Sittingbourne, Kent, for research work in connection with synthetic chemicals and the agricultural products derived from them. Applicants should have a good Honours Degree or an A.R.I.C., together with research experience in some aspect of Physical Chemistry. This position carries a salary in accordance with qualifications and experience, together with attractive pension benefits. Write, giving full details, age, qualifications, past experience, to **STAFF DEPARTMENT (T/SR), "SHELL" RESEARCH, LIMITED, 16, FINSBURY CIRCUS, LONDON, E.C.2.**

SENIOR SCIENTIFIC OFFICERS, SCIENTIFIC OFFICERS. The Civil Service Commissioners invite applications for pensionable appointments. Applications may be accepted up to December 31st, 1955, but early application is advised as an earlier closing date may be announced. Interview Boards will sit at frequent intervals. The Scientific posts cover a wide range of scientific research and development in most of the major fields of fundamental and applied science. In biological subjects the number of vacancies is small; individual vacancies exist for candidates who have special knowledge of, or who are interested in palaeobotany, foraminifera, and recent and pleistocene mammals.

Candidates must have obtained a University Degree with First- or Second-class Honours in an appropriate Scientific subject (including Engineering) or in Mathematics, or an equivalent qualification; or possess high professional attainments. Candidates for Senior Scientific Officer posts must in addition have had at least three years' post-graduate or other approved experience.

Candidates taking their degrees in 1955 may apply before the result of their degree examination is known.

AGE LIMITS.—Senior Scientific Officers, between 26 and 31, but specially suitable candidates under 26 may be admitted. For Scientific Officers, between 21 and 28 during 1955 (up to 31 for permanent members of the Experimental Officer class). Salary (London): Senior Scientific Officers—(men), £1,010-£1,185; (women), £893-£1,077. Scientific Officers—(men), £492-£885; (women), £492-£795. Women's scales subject to improvement under equal pay scheme. Somewhat lower rates in the provinces.

Further particulars from **CIVIL SERVICE COMMISSION, SCIENTIFIC BRANCH, 30, OLD BURLINGTON STREET, LONDON, W.1,** quoting No. S.53/55 for Senior Scientific Officers and S.52/55 for Scientific Officers.

WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH, NIGERIA

APPLICATIONS are invited for the post of **RESEARCH ENGINEER**, at the **WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH.**

Duties are primarily research and development in connection with engineering problems, particularly those arising in the processing of oil palm fruit in plantation oil mills of various kinds. The officer will be required to work in close collaboration with other members of the Institute staff concerned with the production of the crop in the field and will be required to modify existing plant or design new.

Appointment is either pensionable or on contract in the gross salary range £1,172 10sh. to £2,037 10sh. per annum, with a gratuity of £122 to £275 10sh. per annum in the case of a contract appointment.

Free passages are provided for the officer, his wife, and all children under 13 years of age. Furnished Government quarters are provided, if available, at a rental of 10 per cent basic salary subject to a maximum of £150 per annum. Leave is granted at the rate of seven days for each completed month of resident service.

Candidates, not less than 26 years of age, should hold a good Honours Degree in Mechanical or Chemical Engineering, and have had at least three years' post-graduate experience in the design and operation of plant for vegetable-oil extraction and processing. They must possess a " research outlook " and should be well versed in the critical appreciation of practical problems from a scientific angle. They must be well qualified engineers with a particular aptitude for mechanical matters, and have a good knowledge and experience of Chemistry.

Apply, in writing, to the **DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, GREAT SMITH STREET, LONDON, S.W.1,** giving briefly age, qualifications and experience. Mention the reference number BCD197/199/0/—.

LABORATORY SUPERINTENDENTS are being sought to take charge of product testing and process control on a shift basis for a new factory in South Wales. Bonus, generous holiday and Non-contributory Pension Scheme. Salary commensurate with age and experience. Applications to be made to **BOX No. C.A. 3413, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4,** quoting ref. D.11.

EXPERIMENTAL OFFICERS AND ASSISTANT EXPERIMENTAL OFFICERS, in various Government Departments. The Civil Service Commissioners invite applications for pensionable posts. Applications may be accepted up to December 31st, 1955, but forms should be returned as soon as possible as an earlier closing date may be announced either for the competition as a whole or in one or more subjects. No more applications from meteorologists can be accepted. Interview Boards will sit at frequent intervals.

The posts are divided between following main groups and subjects :—

(*a*) Mathematical and Physical Sciences ;
(*b*) Chemistry and Metallurgy ;
(*c*) Biological Sciences ;
(*d*) Engineering subjects ; and
(*e*) Miscellaneous (including, e.g., Geology, Library and Technical Information Services).

AGE LIMITS.—For Experimental Officers, at least 26 and under 31 on December 31st, 1955 ; for Assistant Experimental Officers, at least 18 and under 28 on December 31st, 1955. Extension for regular service in H.M. Forces. Candidates aged 31 or over, with specialised experience for Experimental Officer posts, may be admitted.

Candidates must have at least one of a number of specified qualifications. Examples are : Higher School Certificate, General Certificate of Education, Scottish Leaving Certificate, Scottish Universities Preliminary Examination, Northern Ireland Senior Certificate (all in appropriate subjects and at appropriate levels), Higher National Certificate, University Degree. Candidates taking their examinations in 1955 may be admitted. Candidates without such qualifications may be admitted exceptionally on evidence of suitable experience. In general, a higher standard of qualification will be looked for in the older candidates than in the younger ones.

SALARY (London) : Experimental Officer, £750-£920 (men), £663-£808 (women). Assistant Experimental Officer, £302 (at age 18) to £670 (men), £584 (women). Starting pay up to £545 (men) or £516 (women) at 26. Somewhat lower outside London. Promotion prospects. Women's scales subject to improvement under equal pay scheme.

Further particulars from **CIVIL SERVICE COMMISSION, SCIENTIFIC BRANCH, 30, OLD BURLINGTON STREET, LONDON, W.1,** quoting No. S94-95/55.
6645/a/80/WP/6/55.

MECHANICAL ENGINEERS

A large and well-known industrial organisation has attractive vacancies for University graduates with or without practical experience in the following departments :—

RESEARCH, DESIGN, WORKSHOPS, WORK STUDY, PROCESS ENGINEERING

Excellent prospects of rapid advancement for men who have had a few years practical experience. Practical training on full salary can be provided for graduates taking up a first appointment.

STARTING SALARIES UP TO £1,200 p.a.

PENSION AND WELFARE SCHEMES

ASSISTANCE WITH HOUSE PURCHASE

Write, giving full details of age, qualifications and experience to **BOX No. 3414, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.** quoting Advertisement Reference P.8

Situations Vacant—*Continued*

GRADUATES in **MECHANICAL** and **CHEMICAL ENGINEERING** required for progressive positions in the Research, Design and Production Divisions of THE POWER-GAS CORPORATION LIMITED. Training given to men without previous industrial experience. Apply to:—**STAFF PERSONNEL MANAGER, PARKFIELD WORKS, STOCKTON-ON-TEES.**

IMPERIAL SMELTING CORPORATION, LIMITED, invites applications from **METALLURGISTS, CHEMISTS** or **CHEMICAL ENGINEERS,** for openings in the Plant Investigation Departments at the Avonmouth and Widnes Works. Honours Degree is preferable, previous experience not essential and applications will be welcomed from persons completing their National Service. Opening also available for **PHYSICAL METALLURGIST** in Research Laboratory for investigational work on alloys. Applications, giving full details, to Personnel Manager, Imperial Smelting Corporation, Ltd., St. Andrew's Road, Avonmouth, Bristol, quoting reference **GRA/CA.**

INDUSTRIAL CHEMIST required by leading container closure manufacturers in Midlands. Progressive position requiring knowledge metal printing, varnishing, stoving, and metallurgy, associated with food packaging industry. Maximum age 35 years.—Written applications, with details of experience previous appointments, etc., to **P. A. METAL CLOSURES LTD., BROMFORD LANE, WEST BROMWICH, STAFFS.**

FOR SALE

CHARCOAL, ANIMAL AND VEGETABLE horticultural, burning, filtering, disinfecting, medicinal, insulating; also lumps ground and granulated; established 1830; contractors to H.M. Government.—**THOS. HILL-JONES, LTD., "INVICTA" WORKS, BOW COMMON LANE, LONDON, E. TELEGRAMS: "HILL-JONES, BOCHURCH LONDON." TELEPHONE: 3285 EAST.**

DEHNE FILTER PRESS—26 cast-iron plates, 25 in. by 25 in. 2 in. centre hole; screw 3½ in. diam.; 2 columns 3½ in.; overall 9 ft. by 3 ft. 4 in. by 4 ft. high.

Good condition.

THOMPSON & SON (MILLWALL), LTD., LONDON, E.14.
Tel. EAST 1844.

ECONOMIC BOILERS. Two 8 ft. diam., 220 lb. w.p., 5,000 lb. evaporation; three 7 ft. 6 in. diam., 160 lb. w.p., 4,500 lb. evaporation; 400 other boilers in stock.
STAINLESS PRESSURE TANK, 19 ft. by 5 ft. diam., 110 lb. w.p. Unused.
TWO 35 ft. long by 9 ft. diam. Lead-lined **TANKS.**
TWO Broadbent **WATER-DRIVEN CENTRIFUGES,** 30 in. diam., 12 in. deep, 1,150 r.p.m.
SIX Aluminium **CONDENSERS,** 14 ft. long by 2 ft. 3 in. diam. 386 Tubes, ⅝ in. o.d.
FORTY Riveted **RECEIVERS,** 8 ft. 6 in. long, 5 ft. 6 in. diam., 75 lb. w.p. Numerous other sizes.
Solid Drawn **STEEL PIPES,** 6 in., 8 in., 10 in., 12 in., 14 in., thousands of feet in stock, plain and flanged.
CAST-IRON PIPES, 1,200 yds. 10 in. and 400 yds. 8 in., **NEW.** Also most other sizes, up to 24 in. bore.
VALVES in Stainless, Gunmetal, Enamel Lined.
CAST-IRON TANK PLATES, 2 ft. square. 500 in stock.

FRED WATKINS (BOILERS), LTD.
COLEFORD, GLOS.

SACK AND BAG MERCHANTS AND MANUFACTURERS. New and reconditioned for Home and Export. (Use **JUTEX** for sack repairing). **ALTRINCHAM JUTE LTD, WRIGHT STREET, BROADHEATH. ALTRINCHAM, CHESHIRE.** ALTrincham 4360.

600

13 Totally Enclosed **SOLUTION MIXERS**—12 ft. long by 6 ft. 6 in. diam. Capacity, 10,000 litres. Construction, mild steel plate, with dished ends and heavy glanded spiral-type agitators, motorised 400/3/50. Mounted on mild steel stands. Vessels have top manway 18 in. diam. and 7 in. by 2 in. diam. bottom outlet. W.P., 70 lb.
Vertical **SHELL & TUBE CONDENSER**—cast-iron body, 26 in. o.d., 230 tinned-copper tubes 32½ in. by ⅝ in. i.d. Ribbed cast-iron end covers. Single-pass type. Overall dimensions 39 in. by 33 in. diam.
4 Vertical **SHELL & TUBE CONDENSERS**—each with copper body 26 in. o.d. and 230 tinned-copper tubes 32½ in. by ⅝ in. i.d. Overall dimensions 39 in. by 33 in. diam.
3-stage CO_2 **COMPRESSOR**—by J. & E. Hall. Phosphor-bronze cylinders, pistons and valves. Maximum pressure 1,350 sq. in., 109° F. Mounted on bed-plate and Vee-rope driven from 5 h.p. totally enclosed S.R. motor 400/3/50.
SOLVENT RECOVERY PLANT—by British Carbo Union, comprising 2 horizontal carbon-charged mild steel absorbers, each 6 ft. diam. by 3 ft., with 18 in. bolted manhole, four 8 in. diam. inspection covers, brass tube condenser, separator and distillate collection tank, 20 in. input fan and all connecting pipework. Recovery rate for naphtha, 10 gal. per hr.

GEORGE COHEN, SONS & CO., LTD.,
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070, and
STANNINGLEY, NR. LEEDS.
Tel.: Pudsey 2241.

PHONE 98 STAINES

STAINLESS STEEL AND CHROME PORTABLE STIRRERS OR EMULSIFIERS—1/6, ¼, ½, 1 and 2 h.p. A.C. motors.
(30) **"Z" AND FIN BLADE MIXERS**—up to 38 in. by 31 in. by 28 in. deep.
STAINLESS STEEL GAS-HEATED JACKETED PANS—25 and 35 gallons.
"DEHNE" WOOD PLATE FILTER PRESS—31 30 in. sq. plates.
WELDED STEEL JACKETED TANKS—15 ft. by 4 ft. by 4 ft., 10 lb. w.p.
UNUSED "WEIR" CONDENSERS—105 sq. ft. tube area.
HYDROS—30 in. and 36 in., 400/3/50.
PUMPS, BOILERS, AUTOCLAVES, STILLS, RECEIVERS, REFINERS, OVENS, CRUSHERS AND GRINDERS, etc.

HARRY H. GARDAM & CO., LTD.
STAINES.

FOR SALE—Railway Safety Crates for 10 gall. cbys. unused only require redipping, in lots of 150. 5/- each f.o.r., Nutfield Station. Also quantity of Rough Neck 10 gall. Carboys (naked) in lots of 150 5/- each f.o.r. Nutfield Station.—Apply: **NUTFIELD MANUFACTURING CO., LTD., SOUTH NUTFIELD, SURREY.**

SELWOOD FOR PLANT
STORAGE TANKS FOR SALE.

HORIZONTAL CYLINDRICAL. 500 gallon to 12,000 gallon, new and secondhand.
VERTICAL CYLINDRICAL. 250 gallon TVO to 9,000 gallon.
RECTANGULAR ENCLOSED. 100 gallon to 1,200 gallon, new and secondhand.
OVAL LORRY MOUNTING. 200 gallon to 4,000 gallon, all types.

FULL LISTS ON REQUEST.
WILLIAM R. SELWOOD LIMITED, CHANDLER'S FORD, HANTS. Phone 2275

TWO **BRAND NEW STERILISING VESSELS**—7 ft. long by 3 ft. diameter.
One **S. J. WERNER MIXER** with pan approx. 2 ft. by 2 ft. of the tilting type.
Two steam jacketed **CAST-IRON FILTER PRESSES**—each with 38 s.j. plates and 39 frames, cake size 2 ft. 4 in. square.
Several **JOHNSON CAST-IRON FILTER PRESSES**—various sizes and types.
GARDNER MIXERS and Mixers and Sifters combined, sizes "E," "G," "H" and experimental.
HYDRO EXTRACTORS—24 in., 30 in. and 36 in.
Two Gardner "H" size Steam-jacketed **MIXERS.**
Two 18 in. **KEK PLATE MILLS**—with feeders delivery bins, motors and entablature.
Two No. 4 **SUPER MIRACLE MILLS** with motors and starters.
Three Single-effect **EVAPORATORS** by Scott with pumps and motors.

RICHARD SIZER, LTD.
ENGINEERS,
HULL.
Telephone : 31743.

WANTED

WANTED, Rovac Endflow Rotary Filter, approx. 35 sq. ft. Price and full particulars to **WARRINGTON CANNERS, LTD., WARRINGTON.**

WORK WANTED & OFFERED

CRUSHING, GRINDING, MIXING and DRYING for the trade.
THE CRACK PULVERISING MILLS LTD
Plantation House,
Mincing Lane.
London, E.C.2.

GRINDING, CRUSHING AND GRADING
FINE GRINDING LTD.,
BLACKHOLE MINE, EYAM
TELEPHONE : EYAM 227

PULVERISING of every description of chemical and other materials for the trade with improved mills wharfage, and storage facilities. **THOS. HILL-JONES LTD., "INVICTA" WORKS, BOW COMMON LANE LONDON, E. TELEGRAMS : "HILL-JONES BOCHURCH LONDON." TELEPHONE : 3285 EAST.**

PATENTS & TRADE MARKS

KINGS PATENT AGENCY, LTD., (B. T. King A.M.I.Mech.E., Patent Agent), 146a, Queen Victoria Street, London, E.C.4. ADVICE Handbook, and Consultation free. Phone : City 6161.

THE Proprietor of British Patent No. 652641, entitled "**PROCESS OF PREPARING ANTIBODY-RICH GLOBULIN FRACTIONS,**" offers same for licence or otherwise to ensure practical working in Great Britain. Inquiries to **SINGER, STERN & CARLBERG, 14 E. JACKSON BLVD. CHICAGO 4, ILLINOIS, U.S.A.**

AUCTIONEERS, VALUERS, Etc.

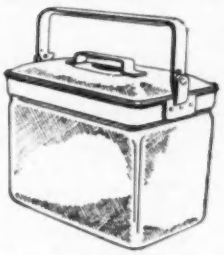
EDWARD RUSHTON, SON AND KENYON (Established 1855).

Auctioneers, Valuers and Fire Loss Assessors of CHEMICAL WORKS PLANT AND MACHINERY
York House, 12 York Street Manchester.

Telephone 1937 (2 lines) Central Manchester.

STAINLESS STEEL VESSELS

Capacity 6 gallons **16" x 11" x 11"**



Complete with lid *as illustrated* PLUS inner anti-splash lid, handle swivels flat, locks lids, thus ensuring complete security in transit.

57/6 each carriage paid
or
£30 for one dozen carriage paid

Todays replacement cost **£8** each

Ex M.o.S., radius corners, sturdy construction 20 gauge, 18/8 stainless steel.
Suitable for most industrial uses and already supplied to many leading chemical plants.
1500 in stock available for immediate despatch.
Export orders welcomed at small additional charges to cover packing and freight.

MYERS & FOULKES (CA)
Grove Green Road, London, E.11. LEYtonstone 1013

CARBOYS: PACKED CARBOYS
CARBOY TILTERS AND BARROWS.
***SAFETY CRATES* TOP PROTECTORS**

May we quote for

Complete Tar Plants, Tar Stills, Benzol Stills, Autoclaves, Vacuum Drying and Impregnating Plants, Jacketted Pans etc. and for all Steel Plate Work for Chemical Processes

LEEDS & BRADFORD BOILER Co. Ltd.
STANNINGLEY Near LEEDS

INDEX to advertisers in this issue

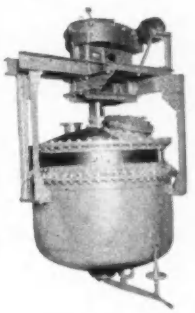
	Page
Aimer Products Ltd.	1374
Alcock (Peroxide) Ltd.	1404
Alexander, Herbert, & Co., Ltd.	1406
Alginate Industries Ltd.	1390
Alumina Co., Ltd. (The)	1371
Ames Crosta Mills & Co., Ltd.	1390
Angel, H. Reeve, & Co., Ltd.	1378
Armour & Co., Ltd.	1475
Ashmore, Benson, Pease & Co.	1477
Automatic Coil Winder & Electrical Equipment Co., Ltd. (The)	1407
Baird & Tatlock (London) Ltd.	1387
Baker Platinum Ltd.	1391
Black, B., & Son Ltd.	1406
Blundell & Crompton Ltd.	Cover iii
Brannan, S., & Sons Ltd.	1378
Britex (Scientific Instruments) Ltd.	1380
British Carbo Norit Union Ltd.	1376
British Drug Houses Ltd. (The)	1485
British Instrument Industries Exhibition	1402
Bush, W. J., & Co., Ltd.	1405
Carbic Ltd.	1388
Catterson-Smith, R. M., Ltd.	1384
Chemitrade Ltd.	Cover iii
Ciech Ltd.	1399
Cinema-Television Ltd.	1397
Classified Advertisements 1490, 1491, 1492,	1493
Cooke, Troughton & Simms Ltd.	1383
Dryden, T., Ltd.	1377
Elcontrol Ltd.	1386
Elliott, H. J., Ltd.	1414
Farwig, J. F., Co., Ltd.	1380
Feltham, Walter H., & Son Ltd.	1413
Ferranti Ltd.	1381
Fleischmann (London) Ltd.	1392
Foster Instrument Co., Ltd.	1385
Foxboro-Yoxall Ltd.	1379
Gallenkamp, A., & Co., Ltd.	Front Cover
Geigy Co., Ltd.	1471
Glebe Mines Ltd.	1382
Harris (Lostock Gralam) Ltd.	Cover iii
Haughton's Metallic Co., Ltd.	1413
Hearson, Charles, & Co., Ltd.	1375
High Pressure Components Ltd.	1473
Hilger & Watts Ltd.	1481
Holmes, W. C., & Co., Ltd.	1384
Holmes Brothers Paint Machinery Ltd.	1413
Hone, F. J., & Co., Ltd.	1396
Hopkin & Williams Ltd.	1409
Imperial Chemical Industries Ltd.	1469
Johnson Matthey & Co., Ltd.	1411
K.D.G. Instruments Ltd.	1386
Kenure, J. F., Ltd.	1400
Kernick & Son Ltd.	1410
Kestner Evaporator & Engineering Co., Ltd.	1398, 1413
Leeds & Bradford Boiler Co., Ltd.	1493
Leigh & Sons Metal Works Ltd.	1493
London Metal Warehouses Ltd.	1367
McCulloch Brothers & Wilson	1489
Marchon Products Ltd.	1369
Markland Scowcroft Ltd.	1408
Measuring & Scientific Equipment Ltd.	1372
Mercantile Holding & Trading Co., Ltd.	1410
Mervyn Instruments	1404
Metalock (Britain) Ltd.	1373
Middleton & Co., Ltd.	1382
Negretti & Zambra Ltd.	Cover iv
Nordac Ltd.	1483
Penrhyn Quarries Ltd.	1413
Philips Electrical Ltd.	1416
Pickstone, R. E., Ltd.	1406
Potter, F. W., & Soar Ltd.	1376
Powell Duffryn Carbon Products Ltd.	1370
Power-Gas Corporation Ltd. (The)	1477
Preston, J., Ltd.	Cover iii
Pyrethrum Board of Kenya	1479
Q.V.F. Ltd.	1395
Rediweld Ltd.	1487
Richmond Welding Co.	1413
Sandiacre Screw Co., Ltd. (The)	1388
Scientific Glass Blowing Co., Ltd.	1392
Southern Instruments Ltd.	1394
Spencer Chapman & Messel, Ltd.	1489
Stanton Instruments Ltd.	1401
Steel, J. M., & Co., Ltd.	1487
Stockdale Engineering Co., Ltd.	1394
Sutcliffe Speakman & Co., Ltd.	1389
Tangyes Ltd.	1403
Thermal Syndicate Ltd. (The)	1398
Towers, J. W., & Co., Ltd.	Cover ii
Townson & Mercer Ltd.	1368
Unifloc Ltd.	1400
Webb, William A., Ltd.	1393
Wood, Harold, & Sons Ltd.	1413
X-Lon Products	1408
Zeal, G. H., Ltd.	1396

Telephone: Northwich 2954
Telegrams: "VULCAN" LOSTOCK GRALAM

"VULCAN"
BRAND
CARBOY HAMPERS,
SAFETY CRATES,
&
PACKED CARBOYS

Sole Manufacturers:
HARRIS (LOSTOCK GRALAM) LTD
LOSTOCK GRALAM, NORTHWICH.

COPPER PLANT
for the CHEMICAL TRADES



Large steam jacketed copper Boiling and Mixing Pan with geared agitators, steam jacket of mild steel

STILLS
RECTIFYING COLUMNS
CONDENSERS

Autoclaves
Calandrias
Vacuum Pans
Boiling Pans
Pipework,
Coils, etc.

ESTABLISHED 1825
BLUNDELL & CROMPTON
LIMITED
WEST INDIA DOCK RD., LONDON, E.14
Phone: East 3838 (3 lines); & 1408
Grams: Blundell, Phone, London

AT YOUR SERVICE
100 YEARS EXPERIENCE
IN THE SUPPLY OF
LABORATORY GLASSWARE & APPARATUS
FINE AND
INDUSTRIAL CHEMICALS

J. Preston, Ltd.
208, WEST STREET, SHEFFIELD.

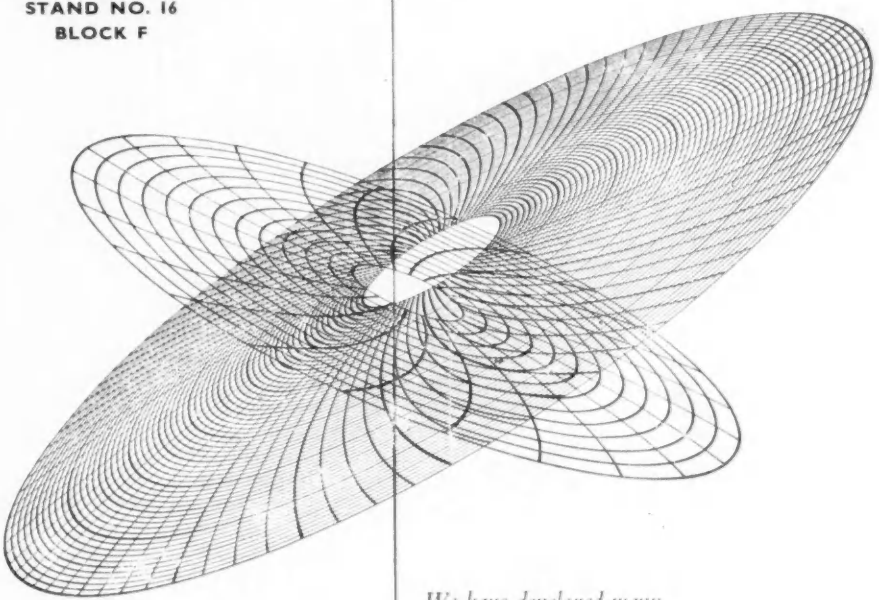
Pure Phenol 39/41°C Crystals
Potassium Ferricyanide
Potassium Nitrate—Double Refined 99/100%
Trisodium Phosphate
Disodium Phosphate
Diethylamine
Barium Nitrate
Formic Acid 90%
Oxalic Acid
Soda Ash Light 98/100%
for export from Hamburg

Enquiries to
CHEMITRADE LIMITED
17 STRATTON ST. • LONDON • W.1
Telephone: GROsvenor 3422
Cables: Multikem, London
Telex: London 8694 Traforchem

BRITISH INSTRUMENT INDUSTRIES EXHIBITION
EARLS COURT LONDON
June 28 - July 6 1955

STAND NO. 16
BLOCK F

INSTRUMENTATION



We have developed many improvements in the design of the Mercury-in-Steel Thermometer. Others have paid us the compliment of imitation — without however achieving our standard of performance. Specify Negretti & Zambra.

Contract, panels and installation service available.

NEGRETTI & ZAMBRA

NEGRETTI & ZAMBRA LTD., REGENT STREET, LONDON

Printed in Great Britain by THE PRESS AT COOMBELANDS LTD., Addlestone, and published by BENN BROTHERS LTD., at Bouverie House, 154 Fleet Street, E.C.4, 25 June, 1955. Registered at the General Post Office. Entered as Second Class Matter at the New York U.S.A., Post Office.

une 1955

ble.

ONDON

OTHERS
Office.